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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF ENTOMOLOGY.
BULLETIN No. 14.

REPORTS

OF

OBSERVATIONS AND EXPERIMENTS

IN

THE PRACTICAL WORK OF THE DIVISION,

MADE

UNDER THE DIRECTION OF THE ENTOMOLOGIST.

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LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., May 30, 1887.

SIR: I have the honor to submit for publication Bulletin No. 14 of the Division of Entomology, containing certain reports of agents and other matter additional to that contained in Bulletin 13, and excluded from my annual report from lack of space.

Respectfully,

C. V. RILEY,
Entomologist.

Hon. NORMAN J. COLMAN,
Commissioner of Agriculture.

CONTENTS.

	Page.
Introduction	7
Report on Insects injurious to Garden Crops in Florida	9
Report on Buffalo Gnats	29
Native Plums. How to fruit them. They are claimed to be practically curculio-proof	39
The Serrell automatic Silk-reel	52

INTRODUCTION.

This Bulletin contains matter referring to the season of 1886, additional to that already published.

Mr. Ashmead's report on insects affecting garden crops in Florida is necessarily very incomplete, as it represents only four months' field observations, and as the subject is one of no inconsiderable magnitude. Mr. Ashmead's work was stopped September 1st on account of the reduction in the appropriations.

Mr. Webster's report on Buffalo Gnats is in the main the results of work in March and April, 1886. It contains many interesting details in addition to the more important observations which are quoted in our own article on the subject in the annual report. It is also due to Mr. Webster to say that the investigations since made, and especially those by himself the present year, have added materially to our exact knowledge on the subject.

In reference to Mr. Wier's article on the curculio-proof nature of the native plums and his explanation thereof we wish to be understood as in no way indorsing either the statements or conclusions of the paper. Mr. Wier is an old friend and correspondent and has written much of late upon this question. He claimed to have abundant personal evidence of the wild plums being proof against *Conotrachelus nenuphar* by virtue of the eggs failing to hatch therein. This was an important matter, bearing directly on economic entomology, and, as we have often been asked for our opinion as to the immunity of these wild plums, we engaged Mr. Wier to prepare a statement of his evidence. His two main claims are (1) that these wild plum trees are unfruitful, except where the flowers receive the pollen from other varieties; (2) that the female Curculio prefers their fruit for purposes of oviposition, but that the egg fails to hatch therein or the larva perishes after hatching. The first point belongs to economic botany, or rather pomology, and while we consider that it is disproved alike by historical and botanical evidence and general experience we leave it with the horticulturist to deal with more fully. With regard to the second point we confess that the reading of Mr. Wier's essay has brought no sense of his theory being well sustained or of its general truthfulness. Yet, for the reasons stated, we have decided to publish the paper very much as received, omitting only such portions as dealt with well known and trite entomological facts, as also a dissertation on grafting, and entering our dis-

sent in the form of foot-note where the statements are unjustified from the entomological side.

The description of the principles and mechanism of the Serrell automatic silk-reel has been prepared by Mr. Philip Walker, assistant in charge of the reeling experiments and machinery at the Department. It will be found useful in explaining the advantages which that delicate and remarkable invention has over the ordinary reel as a labor-saver, though no amount of description will impress the fact on the mind so forcibly as a few moments' observation of the reel at work.

C. V. R.

REPORT ON INSECTS INJURIOUS TO GARDEN CROPS IN FLORIDA.

By Wm. H. Ashmead, *Special Agent.*

LETTER OF TRANSMITTAL.

Jacksonville, Fla.,
September 2, 1886.

Dear Sir: I have the honor to submit herewith, in pursuance to your instructions, my report on "insects injurious to garden crops" in Florida, comprehending field-work and studies on these pests from May 15 to August 31, 1886.

My time was too limited to do full justice to the subject; moreover, it will take several years of the most laborious, painstaking industry to thoroughly work up the life histories of the destructive insect pests affecting our garden crops in this State.

Yours, very respectfully,

WM. H. ASHMEAD.

Prof. C. V. Riley,
U. S. Entomologist, Washington, D. C.

INTRODUCTORY.

The insects depredating "garden crops" in Florida are legion, and the time at my disposal, May 15 to August 31, was too limited to begin to do the subject justice.

Daily rains, too, from latter part of June and all during July greatly interfered with my field-work. During the months of March and April early vegetables are raised in great quantities for northern shipment and consumption, and it is then that the greatest activity exists among certain destructive pests depredating these crops. That is the time investigation should begin. However, considerable work has been accomplished, and in the following pages will be found descriptions of some of the more injurious insect pests injuring these crops; moreover, to make the report of practical value to our vegetable growers, I have given the best remedies known, extracted principally from the writings of Professors Riley, Fitch, Lintner, Packard, Forbes, Thomas, &c.

INSECTS AFFECTING THE CABBAGE.

Probably there is no garden crop in Florida that is so preyed upon and so seriously threatened from the attacks of insect pests as the cabbage and its numerous varieties.

To well-known imported European insect pests, now thoroughly established here and depredating this crop, may be added many indigenous

species that attack and destroy it in different ways, and the injury and loss is very great.

Necessarily I have given considerable time and study to unraveling the life histories of some of the more important ones, giving them that prominence in my report that their importance to the grower seem to warrant.

THE CABBAGE PLUSIA.

(*Plusia brassicæ* Riley.)

This is one of the most serious and destructive of cabbage insects. Prof. C. V. Riley first described it in his Second Missouri Report, 1870, page 110.

Distribution.—While, undoubtedly, originally indigenous to the Southern States, it is now very generally distributed over most of the Eastern and Western States. In U. S. Agricultural Report for 1883, Professor Riley states that he has received it from Mississippi, Georgia, Florida, the Carolinas, Alabama, Texas, New Jersey, Missouri, Kansas, Nebraska, Virginia, and Maryland.

Food Plants.—The food plants of the larvæ, as given in same report, are Cabbage, Kale, Turnip, Tomato, Mignonette (*Reseda*), Dandelion (*Taraxacum*), Dock (*Rumex*), *Crepis*, *Chenopodium*, Clover, *Senecio scandens*, Lettuce, and Celery. Professor Riley also says: "We have also found it in Florida feeding upon the Japan Quince (*Cydonia japonica*), and it has been found in Washington upon same plant."

Life History.—The life history of this insect is treated in the Annual Report of the Department for 1883, pp. 119–122, and it is figured at Plate I, figs. 2 and 2*a*, and Plate XI, figs. 2, *a*, *b*, *c*. The different stages are described in Professor Riley's Second Missouri Entomological Report, pp. 111–112.

Number of Broods.—Professor Lintner, State Entomologist of New York, in treating of this species in his second report, page 92, says: "In its more northern extension there are two annual broods, for, from larvæ taken in August, after about two weeks of pupation, Dr. Thomas has had the moths emerge on the 1st of September, which deposited their eggs for a second brood in October. In the Southern States there are probably four broods, for Mr. Grote took examples of the moths in Alabama during the last of February."

Here in Florida there are certainly not less than six broods, for I have taken the moths every month but the winter months, November, December, and January.

Its Injuries.—Not a cabbage patch visited by me this spring and summer but was more or less damaged by the attacks of this terrible cabbage pest, and the injury it does and the loss sustained by the trucker is immense.

The very young begin by eating the fleshy portion of the leaves; as

they grow in size and strength they gnaw irregular holes through the leaves, until they are completely riddled or honey-combed and the cabbage rendered thereby unmarketable.

Natural Enemies and Parasites.—Comparatively few natural enemies have been observed preying upon this insect, although carabid beetles and others are supposed to destroy it at the North.

A European chalcid fly, *Copidosoma truncatellum* Dalman, has been reported as parasitic on this species at Washington, by Mr. L. O. Howard; twenty-five hundred and twenty-eight specimens of this parasite were actually counted as coming from a single parasitized worm.

Professor Riley has also bred an ichneumon fly, *Apanteles congregatus* Say, from larvæ.

Here, in a single instance, I bred from a chrysalis an ichneumon fly (*Limneria*, sp.) a common parasite of the Cabbage Plutella, and it will be found treated further on under the parasites of that insect.

From the egg, however, I bred a pretty little chalcid fly (*Trichogramma pretiosa* Riley). It was first described by Professor Riley in Canadian Entomologist Vol. XI, page 161, from specimens bred from the eggs of the Cotton Worm (*Aletia argillacea* Hübn.).

Besides the above parasites, three larvæ were brought under my observation, attacked by the parasitic fungus (*Botrytis Rileyi* Farlow).

Remedies.—*Pyrethrum.*—Professor Lintner recommends pyrethrum: "A tablespoonful of good fresh powder, diffused through 2 gallons of water and sprinkled over the plants, would destroy the larvæ."

Hot Water.—Every worm visible upon the cabbages may be killed by the use of water at the temperature of 130° Fahrenheit, or 55° centigrade. The water may be boiling hot when put in the watering-can, but it will not be too hot when it reaches the cabbage leaves. The thick fleshy nature of the leaves enables them to withstand considerable heat with very little injury. The sacrifice of a few heads of cabbage will soon teach an experimenter how far he can go with the hot water. It may be sprinkled over the plants from a fine rose watering-can or poured on with the sprinkler removed. If it is very hot it will color some of the leaves, but even where the cabbage is considerably sorched it will recover and renew growth from the heat. (Prof. C. V. Riley).

Kerosene Emulsion.—The kerosene emulsion, as formulated by Mr. H. G. Hubbard for scale insects, will also be found valuable for cabbage worms.

Lime and Carbolic Powder.—This is also good. Take 20 parts superphosphate of lime, 3 parts fresh air-slaked lime, and 1 part carbolic powder; mix, and scatter a small quantity upon each cabbage head three or four times at short intervals about three days apart. The carbolic powder is made by taking sawdust and thoroughly impregnating it with carbolic acid.

THE CABBAGE PLUTELLA.

(*Plutella cruciferarum* Zeller.)

Second only in importance to the Cabbage Plusia is another cabbage worm, the "Cabbage Plutella," the larva of a small moth, and which may easily be confounded with the very young larva of the Cabbage Plusia.

This insect was treated at some length in Professor Riley's Annual Report as Entomologist to the Department for 1883, and it will therefore be unnecessary to go into detail here. I may state, however, that while at the North there are probably but two annual generations, there are at least four here in Florida. The larvæ are quite plentiful on cabbage from the last of February to July, and again in the fall. The damage done is very similar to that of the Plusia and is almost as great, although it seldom attacks other than the outer leaves.

I have bred a parasite, additional to those mentioned by Professor Riley, which agrees with the description of Cresson's *Limneria obscura*.

THE CABBAGE APHIS.

(*Aphis brassicæ* Linn.)

The Cabbage Aphis (*Aphis brassicæ*) first described by Linnæus, in his "Systema Naturæ," is quite widely spread throughout this country and Europe. It was undoubtedly imported into this country at a very early day, for Dr. Fitch shows, by reference to the Transactions of the New York State Agricultural Society for 1791, that it was already known as a cabbage pest at that early date, and at this day it has spread to most parts of the world where the cabbage is cultivated.

Food Plants—It is found on the Turnip, Raddish, Field-cress (*Isatis tinctoria*), Shepherd's-purse (*Capsella bursa-pastoris*), Charloch (*Brassica arvensis*), Cabbage, and other cruciferous plants.

Here I found it on Cabbage, Turnip, and Raddish.

Its Life History.—*The Young.*—These are oval, about .01 inch in length, and of a greenish-yellow color, without the mealy coating of the older ones.

Buckton, the British authority on the Aphididæ, thus describes the different forms:

Apterous Viviparous Female.—Body long, oval; plentifully covered with a whitish mealy coat, both on the upper and under sides. When this is removed by a drop of spirits of wine the body below is grayish-green, with eight black spots ranged down each side of the back, which increase in size as they approach the tail. Antennæ green with black tips, shorter than the body. Eyes and legs black. Cornicles very short and black. Tail also small and black.

Winged Oviparous Female.—Head, neck, and thoracic lobes black. Antennæ and nectaries dark brown. Eyes black. Rest of the body yellowish-green. Abdomen with a row of fine punctures on each lateral edge, with several obscure transverse dorsal marks. Legs dusky brown, pilose. Tail dark green or brown; hairy. Cor-

nicles short and brown, as also is the tip of the rostrum. This last organ reaches to the second coxæ. Wings rather short, with stout coarse veins and stigma.

Its Injuries.—The injuries this species does are more apparent in early spring and late fall than at any other time, for it is then that they are most plentiful, and less subject to the attacks of their numerous natural enemies.

They are found in colonies, on the upper and lower surface of the leaf; often hidden in the wrinkles and folds of the leaf, deep down at its base and on the leaf-stalk.

Buckton says: "Both the upper and under sides of the foliage of which last plant (*Brassica oleracea*) it often crowds in such numbers that the leaves become hidden by the living mass. Indeed sometimes, weight for weight, there is more animal than vegetable substance present. The leaves then become putrid, offensive in odor, and quite disgusting to the eye."

It is seldom that plants are so badly infested in Florida as described by this author, although some years ago I did see old cabbage-stalks that had been left go to seed in an old cabbage patch so affected.

Every stalk was literally covered, promiscuously piled one upon another, with living, pumping, slimy aphids, rendered such by the exuding sap of the plants. I was unable to touch a portion of the stalk without my fingers being covered with the slimy, viscid mass.

Natural Enemies and Parasites.—Fortunately, in Florida, the species has very many natural enemies and parasites which keep it from increasing very rapidly.

In Europe, too, it has several parasites. Buckton mentions a *Coruna*, a *Ceraphron*, and a *Trionyx* (*T. rapæ* Curtis) as having been bred from it in Europe; also "several species of Syrphidæ and Ichneumonidæ act effectually as checks upon the increase of *A. brassicæ*. The larvæ of the former dipterous flies, living in the midst of such plenty, soon gorge themselves and become of great size."

Trionyx rapæ Curtis has also been bred from it in this country. It was received at the Department February 27, 1880, from Norfolk, Va., and redescribed by Mr. Cresson in the Annual Report, U. S. Department Agriculture for 1879, page 260, as a new species, *Trionyx piceus*. Professor Riley bred it at Saint Louis, Mo., as early as 1871, and I have bred it here in great quantities in May, June, and July.

It is one of the principal checks in keeping this pest within bounds, and but few of the Aphids escape its sting.

But there are other parasites; and below I give descriptions of several others bred here which are apparently new and as yet undescribed.

The rearing of a parasitic Cynips from this species is quite interesting, inasmuch as the habits of but few of our species are known. Up to the present time *Allotria avenæ*, *A. tritici* Fitch, and *A. lachni* Ashm. are the only Cynipids bred from Aphids in North America.

THE CABBAGE APHIS ALLOTRIA—*Allotria brassicæ* n. sp.—FEMALE.—Length .05 inch. Black, highly polished, face and vertex of head testaceous; cheeks broad, convex; antennæ 13-jointed, long, pale yellowish-brown or yellowish towards base, becoming brownish or infuscated at tip; thorax smooth, parapsides distant; scutellum small, round, convex, with a deep transverse groove at base; wings clear, pubescent and fringed with short cilia; veins yellowish, the radial area closed; abdomen globose, with the second segment but slightly longer than the third, highly polished black, but more or less testaceous at base and at vent, and a clump of whitish hairs at base; legs honey-yellow; in dry specimens tawny-yellow.

MALE.—The male is of the same size or slightly smaller than the female, and is easily recognized by the 14-jointed antennæ; the third, fourth, and fifth joints almost equal in length, and all are excised outwardly; the testaceous spot on vertex of head is not so apparent; the pleura are more or less testaceous and the abdomen is ovate.

Described from several specimens bred from June 6th to July 15th.

THE CABBAGE APHIS PACHYNEURON—*Pachyneuron aphidivora* n. sp.—FEMALE.—Length .04 to .05 inch. Head metallic green suffused with purple and purplish black on vertex; shagreened, the sculpture coarser beneath eyes; mandibles large, tridentate; eyes purplish-brown; antennæ brown, pubescent, scape and pedicel darker; thorax purplish-black with bronzy and cupreous reflection, finely reticulately sculptured; scapulæ, golden green; scutellum prominent, convex, rounded; metathorax finely wrinkled; abdomen flat, oval, blue-black, metallic at base and with bronze tingings towards apex, darker beneath; wings hyaline, iridescent, pubescent excepting at base; veins pale yellow, the thickened marginal vein brownish, the stigmal slightly longer than marginal; along outer edge are seven long hairs; legs pale yellowish, coxæ black, anterior and middle femora d usky near base and along upper and lower surface, at least two-thirds their length.

Described from several specimens bred June 6th.

THE CABBAGE APHIS ENCYRTID—*Encyrtus aphidiphagus* n. sp.—FEMALE.—Length .06 inch. Blue-black. Head shagreened, face and mouth parts blue, the facial impression is very deep, eyes brown; ocelli region greenish; antennæ brown; thorax shagreened in wavy curved rugosities, hind margin metallic green; abdomen bronzed, blue-black; wings hyaline, marginal vein short; legs honey-yellow, all femora brown except at tips, a large brown blotch near base of tibiæ, terminal tarsal joints dusky.

Near *Encyrtus sublestus* Howard but the color of the legs will at once distinguish it. Described from several specimens.

THE CABBAGE APHIS SYRPHUS FLY—*Allograpta obliqua* Say.—The larva or maggot of this fly has been taken feeding on the "Cabbage Aphis," and below I give description of its various preparatory stages:

The Egg.—Pearly white, long oval; .03 inch in length, deposited on the leaves among the Aphids.

The Maggot.—It is difficult to distinguish this from many other Syrphid larvæ. The full grown larva measures .25 inch in length, cylindrical, tapering anteriorly to point; it is perfectly smooth, a translucent green, and the viscera are plainly discernible, variously shaded, dark green, yellowish or brownish; the jaws are black; the air vessels, which are visible on either side through the body walls, become contiguous on last segment, where they are connected externally with two small warty spiracles.

The Puparium.—The puparium into which the maggot transforms resembles a cone, with the side attached to the leaf, flattened and held in place by a viscid substance secreted by the larva; its anterior end broad and well rounded, gradually narrowing posteriorly; at the end are still to be seen the two warty tubercles. Color yellow-brown, with occasionally darker shadings.

From the puparium of this fly I have bred the following parasite:

THE SYRPHUS FLY PACHYNEURON—*Pachyneuron allograptae* n. sp.—FEMALE.—Length .08 inch. Black, rather coarsly punctate, with a slight metallic luster. Head large, face and cheeks full; eyes brown; antennæ brown, scape rufous; legs tawny yellow, a large brown blotch on fore and middle femora, while the hind femora are almost entirely brown; abdomen flattened, oval, shiny black; wings hyaline, veins pale brown; the bristles on submarginal vein are not long and are difficult to count.

MALE.—Length .05 inch, otherwise similar to female.

Described from several specimens. The large size of this species and color of legs will distinguish it from others in our fauna.

Besides the above parasites there is a small Coccinellid that preys on the Cabbage Aphis, viz, *Scymnus cervicalis*.

OTHER INSECTS FOUND ON CABBAGE IN FLORIDA.

A Centipede (*Julus multistriatus*) Say, a Cricket (*Tridactylus minutus* Scudder), the Southern Cabbage Butterfly (*Pieris protodice* Boisd.), the Large Cabbage Butterfly (*Pieris monuste* L.), the Cabbage Mamestra (*Mamestra chenopodii* Albin.), the Zebra Cabbage Worm (*Ceramica picta* Harris), the Cabbage Pionea (*Pionea rimosalis* Guen.), the Cauliflower Botis (*Botis repetitalis* Grote), the Harlequin Cabbage Bug (*Murgantia histrionica* Hahn.), and others.

INSECTS AFFECTING CORN.

The lateness of the season at which I began my investigations precluded me from studying insects depredating this crop in its earlier growth; consequently nothing can be reported of the cut-worms and borers that do so much injury to this crop in early spring.

THE CORN WORM.

(*Heliothis armigera* Hübn.)

This well-known insect has been very plentiful and injurious in Florida during the past season. Not a field of corn was free from its attacks, and but few perfect ears could be found that were not bored into by this pest.

From ears taken from a field near Jacksonville I obtained from eight to a dozen worms in each ear, and out of the whole patch hardly an ear could be found that had less than two or three worms in it.

The insect is treated in full in the Fourth Report of the U. S. Entomological Commission, and a repetition of its life-history, habits, and remedies are unnecessary here.

Its Injuries.—Enormous injuries are committed by this worm, whole fields of corn being almost entirely destroyed by it. The eggs are laid on the leaves, and the young larvæ, which hatch therefrom, begin by eating the leaves, but they soon leave these and bore into the tender ears, gnawing and eating them in all directions, so that frequently hardly a perfect ear can be found. At times it is also found at the

base of the tassel, feeding on the accumulated saccarhine juice, found there, just before the tassel emerges from its sheath.

The worms will not only gnaw irregular burrows and feed on corn while in the milk, but the mature larvæ are known at times to continue feeding on mature hard corn.

I have taken on corn two hemiptera or bugs which probably prey on the worm, although not detected in the act—the Wheel Bug (*Prionidus cristatus* L.) and *Euschistus servus* Say. From the egg I bred *Trichogramma pretiosa* Riley, already noticed; but no other parasite has been bred from it by me.

THE CORN MINING FLY.

(*Diastata* sp?)

A mining fly larva is quite frequently met with, making long irregular mines on corn leaves, and while I have not been able to rear the perfect fly, yet I am satisfied it is the same species mentioned by Prof. Comstock, in U. S. Agricultural Report for 1880, page 245, as *Diastata* sp.

Several specimens of a parasite, agreeing tolerably well with Mr. Howard's *Entedon diastatæ*, reared from it at the North, were also bred from it here.

MISCELLANEOUS CORN INSECTS.

A Hemipteron (*Oebalus pugnax* Fabr.) was found in considerable numbers feeding on corn pollen, along with a Capsid and several flies. A fly (*Ortalis* sp.) is common on the stalk, but was not observed to do any injury. A common beetle (*Allorhina nitida* Linn.) was taken, with head immersed in the ear, feeding on corn while in the milk.

OTHER INSECTS INJURING CORN IN FLORIDA.

The following insects also injure corn here: The Corn-stalk Borer (*Diatræa saccharalis* Fabr.); the Corn Bill-bug (*Sphenophorus robustus* Horn.), and the Angoumois moth (*Gelechia cerealella*) and several Cut Worms. From the tassels I have taken the larvæ of *Nola sorghiella* Riley, and in the crib the Corn Weevil (*Calandra granaria*).

INSECTS AFFECTING THE TOMATO.

The cultivation of the Tomato for Northern markets is a rapidly growing industry in Florida, particularly in the southern portions of our State; and thousands of boxes are now forwarded by our growers to Northern commission men every season.

It behooves us, therefore, to keep a watchful eye on the insect depredators of this fruit, for we may naturally expect, with the extension of any horticultural industry, a corresponding increase of insect pests.

Fortunately, no serious damage done this plant by insects has been reported this season, and, while I have been unable to visit West and

South Florida, the sections in which the Tomato is more extensively cultivated, yet studies on insects infesting it in gardens near Jacksonville will, I feel assured, prove of interest.

THE TOMATO WORM.

(*Sphinx Carolina* Linn.)

This is a well-known insect, common in all tomato patches, although the moth into which it transforms is seldom seen, and remains totally unknown to the great majority of our farmers. When you tell them that the worm will change into a large moth, nine times out of ten they express surprise and think it a most wonderful piece of information.

Distribution.—It is quite generally distributed throughout the United States, Mexico, the West Indies, and is not uncommon in South America.

Food Plants.—It feeds on Tomato, Potato, Jimpson weed (*Datura stramonium*), Egg-Plant, Tobacco, and other plants. I took specimens the past season feeding on Poke-berry (*Rivina lævis*).

Its Life History.—*The Egg.*—The egg is spherical, perfectly smooth, and green or yellowish-green in color; diameter about .05 inch.

The Larva.—When full grown it measures over three inches in length. The head and body are dark green, interspersed with greenish-white dots; it is transversely wrinkled; oblique white or greenish-white lateral bands extend from dorsum to spiracles, edged above with bluish and short transverse black lines. The spiracles, excepting the first and last, are blackish, with a yellow dot above and below, all edged with blue, the first and last orange yellow. The shield and terminal prolegs edged below with yellow; the caudal horn is reddish-brown towards tip, and the feet are white, edged with black.

The Pupa.—Length one inch and a half. Dark reddish-brown, with coarse punctures on abdominal segments, and a detached cylindrical thick tongue-case, not quite reaching to tip of abdomen.

The moth is a mottled gray species, with orange spots along the body, and has too often been figured and described to need description here.

Its Injuries.—When plentiful the injury done is considerable, and great care should be taken to remove and destroy them. They eat the leaves and tenderer and terminal shoots, frequently stripping the plant bare, whereby the plant is unable to breathe or mature fruit.

Natural Enemies and Parasites.—I have observed a species of Wasp carrying off the young worms to provision its nest. It is also probable that the Microgaster and Blacas that attack its nearest ally (*Sphinx 5-maculata*) will be found parasitizing this worm.

A Tachina fly, a species of *Mascicera*, has been bred from it in the North by Prof. Riley (Fourth Missouri Entomological Report, page 129). In June I bred from its eggs *Trichogramma pretiosa* Riley, a general egg parasite already noticed, and a species of *Telcas*. Of the former three to six specimens issued from each egg; from the latter two to four.

I submit a description of the Teleas, which is apparently new:

THE SPHINX EGG TELEAS—*Teleas sphingis* n. sp.—Length, .04 inch. Black, smooth, and polished. Head large, much broader than thorax; antennæ 12-jointed, dark brown, sparsely pubescent, the scape barely reaching to the head; pedicel much stouter and larger than first funicle joint, which is small; other joints slightly increase in size to club, which enlarges and widens considerably, and comprises five joints; the antennæ in male are more flagellate. The thorax is ovate, smooth, convex, and sparsely covered with microscopical pubescence.

Under a very high power the head and thorax show a microscopical reticulated scratched surface.

No parapsidal grooves; the scutellum is separated by a deep groove at base and has some wrinkled ridges; metathorax rugose. The abdomen is very flat ovate, and somewhat carinate laterally; on first segment there are three deep transverse, punctate grooves, and the second segment occupies most of the upper surface; surrounding the tip are a few hairs.

Legs clavate; femora and coxæ black or very dark brown; tibiæ brown, with tips; tarsi and trochanters yellowish or tawny; wings hyaline, hairy, and with a distinct, rather long, stigmal vein.

Described from numerous specimens bred in July.

Remedy.—For destroying this worm no better method need be wanted than hand-picking.

The worms are large and conspicuous, easily seen, and no difficulty will attend their destruction. The best time for searching for them is in the early morning and evening; during the middle of the day the majority of them will be found hidden under trash and in the ground at the foot of the vine.

THE TOMATO-STALK BORER.

(*Gortyna nitela* Guen.)

This insect is comparatively rare in Florida, although I have noticed it several times the present season. It has been so often treated in the reports and in popular articles as to need no extended notice here.

THE TOMATO APHIS.

(*Megoura solani* Thomas.)

In some cases brought under my observation this year, this Aphid did considerable damage to tomato vines, particularly in the early spring.

Distribution.—It is pretty generally distributed throughout the United States, although it has not been reported, that I am aware of, west of the Rocky Mountains.

Its Natural History.—Prof. Cyrus Thomas described the species in the Eighth Illinois Report as follows:

Winged Female.—Antennæ 7-jointed, a little longer than the body; first and second joints short; third and seventh longest, nearly equal; fourth a little shorter than the third; the fifth not quite as long as the fourth; sixth about half or less than half the length of the fifth; tubercles prominent. Honey tubes extending beyond the abdomen, excessively enlarged in the middle, and expanding at the tip in trumpet

shape. Tail of moderate length, about one-third as long as the honey tubes, conical. Wings as usual in *Siphonophora;* fourth vein strongly and regularly curved; second fork about equally distant from apex and third vein; stigma elongate, slender and pointed, size large.

General color greenish; tail greenish-yellow at the base, darker at the tip; body greenish or pale greenish-yellow; antennæ dusky. Another winged specimen, probably a male, varies considerably from the above description; the second fork of the third vein is very short and near the apex, and in some cases absent in one wing and present in the other. Honey tubes with the enlargement less than the preceding, and carried nearer to the apex; antennæ also differ slightly in the respective length of the joints. Head and abdomen olive green; thorax and eyes black; antennæ dusky, legs pale, dark at the knees and tarsi.

Pupa.—Elongate oblong in form; very pale with a dark green stripe along the middle of the back, with apparent whitish powder speckled sparsely over the body. Head whitish; base of antennæ greenish-white, rest pale fuscous, dark at the tip of the joints and at the tip of the antennæ; eyes brown; femora greenish-white; tibiæ fuscous; tarsi darker. Honey tubes long, slender, pale at base and dusky at the tip. Tail short, conical, greenish.

The summer broods of this species are viviparous, but there must be a fall sexual brood, containing oviparous females which deposit eggs, from which hatch the early spring broods.

Its Injuries.—This species was first detected in the garden of Col. L. W. Spratt.

The Colonel drew my attention to some sickly tomato vines and showed me others that had died and asked me what was the matter with them. An examination revealed the Aphids along the stem stalk and on some of the leaves, and I feel convinced that these little creatures were the cause of the trouble. Their puncture has a blistering and blighting effect on the vine, and the leaves curl and wither.

Natural Enemies and Parasites.—I detected the larvæ of a Lace-wing (*Hemerobius*) and certain Scymni feeding upon them; also bred from them two internal parasites as follows:

Tomato Aphis Allotria—*Alliotria megourœ* n. sp.—Female.—Length .03 inch. Black, shining. Face testaceous; antennæ long, 13-jointed, subfiliform, dark honey-yellow, infuscated from two-thirds its length to tip; thorax smooth, shining; scutellum oval, convex; abdomen globose, slightly testaceous in certain lights; legs dark honey-yellow; wings hyaline, ciliated, veins yellowish.

Described from one specimen bred May 26th.

The Tomato Aphis Encyrtid—*Encyrtus? megourœ* n. sp.—Male and Female.—Length from .02 to .03 inch. Blue-black. Head finely punctate; eyes large with coarse facets; mouth piceous; antennæ 11-jointed, covered with short pubescence in female, in male with two whorls of hairs on each joint; the flagellum gradually widens towards tip in female, narrower in male; scutellum slightly metallic in female, brighter in male, with some long hairs; abdomen blackish or brownish, short, stout, with long hairs at sides; wings hyaline; veins yellowish; marginal vein very short; legs yellowish, coxæ, femora except at tip, and a broad annulus on upper half of tibiæ darker.

Described from three specimens.

Remedies.—Those recommended for "Cabbage Aphis" will be just as effectual for this species.

INSECTS AFFECTING THE EGG PLANT.

The egg plant is comparatively but little cultivated in Florida, and no serious injury is done it by insect pests.

The "Tomato Worms," *Sphinx carolina* and *Sphinx 5-maculata* are both found on it eating the leaves; also a Tortricid and a Tineid.

A Membracid (*Acutalis calva* Say) is found on the stalk, a Blister Beetle (*Epicauta cinerea* Först.) in blossoms, and occasionally eating the leaves; at times a small black jumping bug (*Halticus bractatus* Say) is very plentiful on both stalk and leaves, as well as *Stictocephala inermis* Fabr., and on the under surface of the leaves an Aphis.

THE EGG PLANT APHIS.

(*Siphonophora cucurbitæ* Middleton.)

Distribution.—This species was first detected on Squash vines at Carbondale, Illinois, May, 1878, by Miss Nettie Middleton, and described in Eighth Report Illinois Insects, page 67, and I know of no other reference to it. The specimens found here on Egg Plants agree perfectly with her description, and it is probably extensively distributed over the Eastern United States on various plants belonging to the Cucurbitaceæ.

I quote her original description:

Winged Specimens.—Large and green. Antennæ very long, reaching to or beyond the tip of the tail; third joint a little longer than the fourth; fourth about the same length or very slightly longer than fifth; sixth not more than one-fourth or one-third the length of the fifth; seventh longest; wings transparent; veins slender; the first fork makes a very acute angle with the third vein; second fork rather nearer the third vein than the apex; fourth vein curves sharply and approaches somewhat closely in its middle to the first fork; stigma elongate and narrow; honey tubes long, slender, and cylindrical, extending beyond the tip of the abdomen, but not to the tip of the tail, about one-fifth the length of the body; tail long, subconical, more than half the length of the honey tubes (in the wingless specimens). The form of the body in both the winged and wingless specimens is elongate and fusiform, the latter being slightly broader than the former. Length of body .10 inch, to tip of wing .18 inch, and some appear to even exceed this size; body green; head paler, more or less yellowish; thorax pale brownish or fawn colored or tinged with this color; abdomen green, with a darker green median line; first and second joints of the antennæ pale, third dark, seventh light, shades of light and dark more or less alternating; honey tubes green at base, changing to fuscous at the tip; tail greenish; eyes brown; stigma pale.

Wingless Specimen.—Green, with few markings: Body slightly broader than winged specimens, and elongate ovate; the abdomen tapering posteriorly to the elongated tail, which is elongate conical, its length more than half and almost equal to that of the honey tubes. The honey tubes are long, somewhat robust and cylindrical; they extend beyond the tip of the abdomen, although the posterior tapering segments are much drawn out, but not to the tip of the tail. In most of the specimens examined under a strong magnifying power they appear slightly and minutely wrinkled transversely, or what may perhaps better describe the appearance, pustulate or scaly. The

length of body is usually rather greater than of the winged specimens. In both the antennæ and front of the head are hairy, and many of the hairs appear to be capitate.

Its Injuries.—It is only in early spring that the plant suffers much from this Aphid, and then almost any wash would destroy it; later the rains and natural enemies almost totally destroy it.

Parasites.—Enemies that are usually found destroying plant-lice—Coccinellidæ and Hemerobiidæ—were also observed associated with this species; but besides these I bred from it a parasitic Cynipid as follows:

The Egg Plant Aphis Eucoila, *Eucoila siphonophoræ* n. sp.—Male.—Length, .05 inch; dark, piceo-black; polished; in shape somewhat linear; antennæ longer than body: 15-jointed; filiform, red; third joint longest, excised; following joints long, moniliform; scutellum cupuliform; abdomen slightly compressed, with hairy girdle at base; legs red; posterior coxæ rather large, somewhat pale; wings hyaline, pubescent, and ciliate.

Described from one specimen, bred May 30.

INSECTS AFFECTING THE PEA.

There are several insects destroying the Pea in Florida, but it was too late in the season when I began my work to study them in the field, the Pea crop being about over.

Crickets, grasshoppers, beetles, and caterpillars cut and eat the leaves and pods; but by far the most destructive is a root-mining Anthomyid fly, which preys upon the roots.

Its existence is entirely unsuspected by the grower, and I hope another season will enable me to thoroughly work it up.

The maggots bore into and burrow the roots near the crown, and in a short time flourishing and luxuriant vines are killed.

Our people attribute the cause to the hot weather, and would be surprised could they see the larvæ at work.

INSECTS AFFECTING THE BEAN.

The same general remarks made in regard to insects of the Pea will apply to the Bean also, and I have only been able to work up the life history of one "Cut-worm," taken while in the act, in June.

THE BEAN CUT-WORM.

(*Telesilla cinereola* Guenée.)

The moth of this species has long been known to collectors, but the caterpillar, I believe, up to the present time, remains unidentified and undescribed.

Distribution.—Found generally spread over the United States east of the Rocky Mountains and in Canada and the West Indies. Professor Snow reports it common in Kansas; in Florida it is rare.

Its Life History.—*The Egg.*—Unknown.

The Larva.—This in shape and size very much resembles the Cabbage Worm (*Plusia brassicæ*,) and, like it, when disturbed draws itself up and has the appearance of a geometrid larva. When full grown it measures one and one-tenth of an inch in length. Pale green, with a wavy, yellow stigma line and a supra-stigma creamy white line and two pale dorsal lines, 8 transverse black warty dots on segments with two more on dorsum back of these, from all of which issue pale hairs; on either side of the dorsal black warty tubercles is an irregular yellowish line, and an indistinct yellowish oblique line extending from the outer line obliquely between the first pair of tubercles and last pair to the dorsal lines. The six true legs are pale, glassy, and there are prolegs on ninth, tenth, and anal segments. Head green, with sutural edges dark and a few hairs at sides.

The Pupa.—Length, .42 inch; greatest width, .15; wing cases, .21 inch; pale yellow brown, the fifth segment rather strongly constricted anteriorly and widest; the edges of all the segments anteriorly dark brown.

The Moth.—Wing expanse from one inch and ten-hundredths to one inch and fifteen-hundredths. The fore wings are grayish brown, with a few short, indistinct, wavy, lighter grayish lines interspersed; transversely across the fore wing near the outer margin is a light gray or slightly yellowish band.

The hind wings are uniformly gray, fringed with short cilia; beneath, silvery gray with numerous brownish gray scales at anterior margin and on fore wing.

Its Injuries.—The worm feeds on the leaves and the bean pods, sometimes stripping the vine bare.

OTHER BEAN INSECTS.

A Katydid (*Phylloptera oblongifolia* Dels.), a Butterfly larva (*Eudamus proteus* Linn.), and a Tineid are also found damaging this crop.

INSECTS AFFECTING THE SQUASH.

In Florida there are many insects found feeding on this plant; the Cucumber Flea-beetle (*Crepidodera cucumeris* Harris), the 12-spotted Diabrotica (*Diabrotica 12-punctata* Oliv.), a jumping bug (*Halticus bractatus* Say), the False Chinch (*Triphleps insidiosus* Say), a Mining Fly (*Oscinis*), and an Aphis (*Aphis cucurbitæ* Buckton) are common on the leaves and stems, but have not been observed to do much injury. The life histories of and observations concerning the more injurious are given below.

THE SQUASH BUG.

(*Anasa tristis* DeGeer).

When this bug exists in quantities probably there is no more injurious insect known to squash and pumpkin vines. The mature bug hibernates in the winter under débris, old vines, dry grass, boards, &c., and from early spring to late fall there is a continual succession of broods.

I have taken some specimens in mid-winter, on warm days, in old fields and on fences.

Distribution.—It is found generally throughout the United States and

in Canada; *Anasa uhleri* Stal., found in Mexico, will probably prove to be nothing but a climatic or varietal form of this well-known insect:

Its Life History—*The Egg.*—Length, .04 inch; oval, flattened on three sides, so that when viewed from either end it has a triangular appearance; in color it is dark golden bronze. To the unassisted eye it is smooth and shining, but when viewed under a high-power lens the surface is reticulated.

The Larva.—When first hatched the young bug is broadly oval, with long antennæ, the joints of which are flat, hairy; the head, thorax, and wing-scales blackish, while abdomen is a bright ocher yellow. Length, .08 inch.

Its Injuries and Food Plants.—It confines its attacks almost exclusively to the Squash and Pumpkin, although it is not improbable that other cucurbitaceous vines also suffer from it.

The bug punctures the leaves and the stem of the vine, causing them to wrinkle and wither; also the fruit.

The eggs are laid in patches, twenty or thirty together, on the upper or lower surface of the leaves, fastened to the leaf with a sticky or gluey substance, at night or just before dark, for during the day these disgusting bugs seek shelter in the ground or under trash at the base of the vine stalk.

It is curious to watch them come forth from their hiding places as the sun sinks and darkness begins to fall. Brood after brood march up the vine, led by an older one, like the different corps of an army march to the parade ground at roll call. They come from everywhere—in the ground, under grass, trash, and boards. Indeed, it is astonishing to see how soon vines will be crowded with these bugs, where but a few hours before not one could be found.

Natural Enemies and Parasites.—Birds and fowls, on account of their peculiar odor, will not feed on them, and beetles, wasps, and spiders, which attack caterpillars and other insects, shun it as a foul thing. Fortunately, however, there are parasites that prey on the egg, and thus greatly diminish it, although no author that I am aware of mentions this fact. It was therefore a surprise and a gratification for me when I bred three distinct parasites from the eggs the past summer—a Eupelmid, an Encyrtid, and a Telenomid.

The Squash-bug Egg Telenomus—*Telenomus anasæ* n. sp.—Male and Female.—Black, very coarsely irregularly reticulately punctate, with white pubescence; antennæ in female clavate, 12-jointed, brown; in male flagellate, 14-jointed, pale brown; legs, pale brown or yellowish brown; coxæ, black; abdomen in female, ovate, sub-convex above, highly convex beneath, and with a light carina at sides; in male somewhat fusiform. Wings, hyaline, with a slight fuscous tinge, pubescent, the marginal vein very short, post marginal long, while the stigmal is about two-thirds as long as post marginal; all yellowish.

Described from numerous specimens bred in June and July.

About thirty per cent. of the eggs collected were parasitized by this insect.

The Squash-bug Egg Encyrtid—*Encyrtus anasæ* n. sp.—Female.—Length, .05 inch; robust; head and thorax blue-black; abdomen and tip of scutellum cupreous; the very large pleura and cheeks are decidedly blue; antennæ and legs pale brown; the

scape at base and tarsi yellowish. The femora have a large bluish-black blotch in the middle.

Described from two specimens.

The Reduvius Egg Eupelmid—*Eupelmus reduvii* Howard.—Seven specimens of what I have identified as this species were bred from Anasa eggs in July.

For a description of the species see Canadian Entomologist, Vol. XII, page 207.

THE SQUASH BORER.

(*Eudioptis nitidalis* Cramer.)

The worm so commonly found with us boring into squashes, at the North goes under the name of "Pickle Worm." There it is found eating the leaves and boring into the fleshy portions of the Cucumber.

Distribution.—It is found in the West Indies, throughout the United States, and in Canada.

Food Plants.—As a borer it is found in Squash, Cucumbers, and Melons, but it will also feed on the leaves of all of these vines. The moth is very common and it must have other food plants; Guenée mentions a species of Potato as its food plant.

Its Injuries —The worms bore cylindrical holes into the Squash, and feed on the fleshy pulp, causing it to rot and decay.

Parasites.—From one of the pupæ I bred a Chalcid fly, *Chalcis ovata*, Say, but no other parasites are known to infest it.

Remedy.—Professor Riley, Second Missouri Entomological Report, p. 70, suggests "overhauling the vines early in the summer, and destroying the first worms that appear, either by feeding the infested fruit to hogs or cattle, or by killing the worms on the spot."

THE SQUASH VINE BORER.

(*Melittia ceto* Westw.).

This well known insect, unlike *Eudioptis nitidalis*, does not bore into the Squash or fruit, but into the stem of the vine, often killing it.

I have taken two or three borers at a time from a single stem, and in confinement they proved to be cannibalistic—feeding upon one another—as was exemplified with some I attempted to rear this summer.

No borers were observed in the vine until July.

Distribution.—Found generally throughout the United States.

Food Plants.—Its attacks are almost strictly confined to the Squash, although it has been reported to bore at times into Pumpkin vines.

Its Life History.—*The egg.*—The egg is oval and of a dull red.

The Larva.—Full grown larvæ measure from one inch to one inch and a fourth. Somewhat depressed, fleshy, soft, tapering at each extremity ; segments ten in number, very distinct, the incisions being deep; the eleventh or last segment minute, and hardly distinct from the tenth. Head retractile, small, brown, paler on the front, and with the usual V-like mark on it. First segment or collar with two oblique brown marks on the top, converging behind. A dark line, occasioned by the dorsal vessel

seen through the transparent skin, along the top of the back, from the fourth to the tenth rings inclusive. True legs six, articulate, brown; prolegs wanting or replaced by double rows of hooks in pairs beneath the sixth, seventh, eighth, and ninth rings, and two single rows under the last ring. Spiracles brown. A few very short hairs on each ring, arising singly from little hard points or pit-like, warty substances.

The Pupa.—This is inclosed in a cocoon made of the squash stalk, tied together with a few silken threads.

The Moth.—The wings expand one inch and one quarter. Opaque lustrous, olive-brown; hind wings transparent, with the margin and fringes brown; antennæ greenish black, palpi pale yellow, with a little black tuft near the tip; thorax olive; abdomen deep orange, with a transverse basal black band, and a longitudinal row of five or six black spots; tibiæ and tarsi of the hind legs thickly fringed on the inside with black, and on the outside with long orange-colored hairs; spurs covered with white hairs. (Harris.)

Its Injuries.—The female moth lays an egg on the vine near the roots; the worm which hatches therefrom bores into and feeds on the soft succulent interior of the stem, particularly at its origin near the ground, and at the base of the leaves; frequently when small the worm bores even into the larger leaf-veins. It may easily be detected at work by the withering of the leaves and stem.

Parasites.—I know of no parasites bred from this borer; although I have a large, beautiful, golden green Pteromalid, captured on the vines, that may possibly prove to be its parasite; others were seen on the vine or its vicinity.

Remedies.—The following suggestions and remedies will be found useful in destroying the pest:

Cutting out the larvæ.—This method has been long in use by gardeners, and with a little practice one soon becomes quite expert in detecting and removing the larvæ.

Bisulphide of Carbon in the Ground.—Prof. C. V. Riley first suggested the use of this insecticide in destroying grape phylloxera and Prof. A. J. Cook has since used it successfully in destroying this borer. He says: "A small hole is made in the earth near the main root of the plant by the use of a walking-stick or other rod, and about a teaspoonful of the liquid poured in, when the hole is quickly filled with earth and pressed down by the foot." In every instance the insects were killed without injury to the plant.

Gas-lime.—Fresh gas-lime, liberally distributed, after the removal of the crop, will kill the larvæ within the cocoons. It is well also to follow Professor Lintner, who says: "An infested crop should not be followed by another upon the same ground."

Treatment with Saltpeter.—"Four tablespoonfuls dissolved in a pail of water, and about a quart applied to each hill where an attack was noticed and the leaves were wilting, at the time when the vines were just beginning to run nicely, effectually arrested the attack and a fine crop followed." (*Country Gentleman.*)

INSECTS AFFECTING THE MELON.

There are two insect pests which seriously damage this crop in Florida—a borer and an Aphis—both damaging the crop annually to the extent of thousands of dollars.

THE MELON BORER.

(*Eudioptis hyalinata* Linn.)

In July the melon crop (Cantaloupes and Musk-melons) is almost totally destroyed by the injuries committed by this worm. By the end of the month hardly a melon can be found that has not been bored into by this destructive pest.

Distribution.—It is a common and extensively distributed species over North America, the West Indies, and South America. Guenée also records having received it from French Guiana.

Its total annihilation is devoutly wished for by growers and lovers of good melons, and a preventive from its attacks greatly desired.

Food Plants.—In several instances I have taken the larvæ in Squash, but it is almost exclusively confined to the Melon. From two to six worms have been taken from a single nutmeg melon. Guenée states it is found in Pumpkins, Watermelons, and other cucurbitaceous plants. Now, I have never yet found a borer in Watermelons, and the statement that this worm is found in this fruit must be taken *cum grano salis.*

The Larva.—Length eight-tenths of an inch. Color translucent green or pale greenish-yellow, with the head and cervical shield yellowish; the jaws and surroundings of mouth parts black; from both sides of head issue some fine hairs; the stigmata are yellowish; the warty tubercles on the different segments are arranged as in the larva of *Eudioptus nitidalis,* its nearest ally, only they are neither so prominent nor black, but green, and the hairs issuing therefrom are very fine and almost invisible to the naked eye; the legs are the same in both species.

The Pupa.—This is long and slender, seven-twelfths of an inch in length, yellow-brown, darker, and tapering to a point at tail; the wing cases are long and rather narrow, and the antennal case is very long, projecting beyond the base of the 8th ventral segment. All the segments are well separated, microscopally rugose and wrinkled. The pupa is generally inclosed in a loosely-woven web or cocoon made by drawing a leaf together. But this is not always the case. In two instances I found the pupa loose in the soft pulp of the melon, in the juiciest portion, and it was quite lively, twisting its abdomen from side to side and wiggling about like a thing of life.

The Moth.—Wing expanse from one inch and one-sixth to a little over. The wings are translucent, pearly white, iridescent, and with a glossy brown-black border; the abdomen is also pearly white, excepting the last two segments above, which are blackish, and ends in a tuft of hairs or expanded brush, of a buff color, tipped with white and black; the head and the thorax above are brown-black, glossy; the legs are white excepting the fore-thighs and tibiæ, which are discolored above with buff-colored scales; middle tibiæ armed with two spines, one longer than the other; posterior tibiæ similarly armed, but with an additional pair in the middle, beneath.

Its Injuries.—The larvæ begin by eating the leaves, and the diet of the first brood of worms must consist almost exclusively of phyllophagous food. It is only as the melons begin to mature that the worms bore into them; for comparatively few green melons were found affected.

Of the large melons examined, from four to six worms were taken from each, and in every case where this happened the melon had reached its full growth and was undergoing the process of ripening.

This worm does not always bore directly into the interior of the fruit, sometimes confining itself to the outer rind or boring irregular galleries just beneath it; when it attacks the inner or fleshy portion s it is most destructive, excavating long galleries filled with its soft excrements, in which the worm wallows and crawls backward and forward, and the fruit then soon sours and decays.

Parasites.—Two parasites were reported on the worm in the Agricultural Report for 1879. An Ichneumonid fly (*Pimpla conquisitor* Say), and a Tachina fly are represented in Plate III, Fig. 6, of said report. No parasites were bred from it by me, the majority of the pupæ in my breeding boxes having been destroyed by a small red ant.

Remedy.—See Squash Borer.

THE MELON PLANT-LOUSE.

(*Aphis citrulli* Ashmead.)*

My first acquaintance with this plant-louse was made while on an entomological tour to extreme South Florida in April, 1880, on Metacombie Key, where it had completely devastated the melon patch of a Mr. Sands.

Mr. S., who was a native of the Bahamas, termed the disease "Curled Leaf," and was not aware it was caused by an insect, until I convinced him of that fact by showing him the insects through my pocket lens.

Distribution.—At times the species is very injurious to melon vines in Florida, Georgia, and places in the West. Prof. S. A. Forbes treats of this same insect under the name of "the Melon Plant-louse," (*Aphis cucumeris* n. sp.), in the Twelfth Report of the State Entomologist of Illinois, page 83. It was first briefly described by the writer in the Florida Dispatch, New Series, Vol. 1, page 241, July 7, 1882, more than a year previous to the description by Professor Forbes.†

Food Plants.—Its attacks are confined generally to the watermelon vines, although occasionally found on Squash and other Cucurbitaceæ.

In the West its habits seem to be similar. Dr. Cyrus Thomas, in

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* Synonym, *Aphis cucumeris* Forbes, Ill. Insect Rep., XII, p. 83.

† Mr. Ashmead disregards the well-known rules of zoological nomenclature in insisting upon the priority of his *A. citrulli*, as a name attached to a description published simply in the *Florida Dispatch* cannot hold. This species should be known as *A. cucumeris* Forbes.—C. V. R.

the Farmers' Review for September 2, 1880, says: "There has been great complaint among our gardeners this season in reference to a plant-louse that is doing much injury to the nutmeg and muskmelon vines, and also to the cucumber vines. In some instances they have almost entirely destroyed the entire fields of vines."

Its Natural History.—*Very Young.*—Length, .02 inch; greenish yellow; eyes, brown; tips of honey tubes brown; legs pale.

Wingless Female.—Length, .04 inch; yellow; eyes dark brown; honey tubes slightly conical, black; cauda distinct, dark green: legs pale; extreme tips of tibiæ and tarsi black.

Winged Females.—Length, .05 inch, ovate; head and thorax shining black, sometimes with the prothoracic segment green or yellowish; the antennæ are dark and do not reach the honey tubes; abdomen dark-greenish yellow, spotted along sides; honey tubes black, thickest at base, gradually tapering to tip: cauda distinct, greenish yellow or dark green; wings hyaline, with stigma and veins pale yellowish; legs pale, with tarsi and extreme tips of tibiæ and femora black.

Its Injuries.—The viviparous female breeds very rapidly and is soon surrounded by young in various stages of growth. In a brief time these reach maturity, wander off to new leaves and shoots, and begin colonies of their own. When these lice become too numerous they exhaust the vitality of the vine, distort the leaves and cause them to curl up and wither. The growing terminal shoots are also crowded with them, and then the vine can make no headway; it is fruitless and dies.

It is one of the most destructive plant-lice. To illustrate its destructiveness I cannot do better than quote from an article I wrote in Florida Dispatch, July 27, 1882, after investigating its injuries in Georgia:

Some figures here in regard to the damage done by the "Watermelon Aphis" will not be amiss, and will show our planters the necessity for prompt and united efforts in its destruction.

In Georgia the estimated yield of the watermelon crop this year (1882) for shipment was 900 car-loads, or 900,000 melons. Many at the beginning of the season bring $40 and $50 per hundred. However, to keep within a fair valuation and rather below the true amount, we will say they bring $25 per hundred, which equals, in round numbers, for the crop $225,000. Now, what has been the yield? The shipments are nearly over, and they have not yet reached 600 car-loads, a falling off of 33⅓ per cent., or a total loss of $75,000, due mainly to the ravages of an insect!

The above statistics of loss are founded upon data of the estimate yield for but three counties, principally Thomas, Brooks, and Lowndes, in Georgia. In Florida the crop has from the same cause met with a loss still greater, and we are considerably below the estimate when we say the total loss to the planters of the two States is not less than $150,000.

Natural Enemies and Parasites.—These have not been specially studied, but the enemies and parasites will be found to be similar to those of the "Cabbage Aphis"—flies belonging to the family Syrphidæ, the Lace-wings (*Chrysopidæ*), Chalcid flies (*Chalcididæ*,) and Lady-birds (*Coccinellidæ.*)

Remedies.—An important help in their destruction, and to which the planters' especial attention is requested, and which is equally applicable to other crops, is the following, which, if universally carried out, would

materially assist in the destruction of all noxious and destructive insect pests:

Never plant watermelons two successive years in the same field. Plant always in an entirely new field and as far off as possible from ground in which they were grown the previous year.

My reason for recommending this is obvious on account of the peculiarity in the development and propagation of the Aphididæ. The spring and summer broods in the majority of the species are viviparous, while the fall brood of females are oviparous. The last, therefore, lay the eggs, which lie dormant in the ground all winter and hatch with the first warm breath of spring; now, then, if this field is plowed up and other crops planted, the young aphids have nothing to feed on and so perish.

My observation on this species, too, has been, that it is only troublesome in fields planted in melons two or three years in succession; new melon fields are not affected by it, or to such a small extent as to be unnoticeable.

Spraying with a dilute emulsion of kerosene will doubtless prove an effectual remedy as with other plant-lice. The emulsion should be sprayed from the ground up so as to reach the under sides of the leaves, Professor Riley has figured and described devices for this method of spraying in his report as entomologist to the Department for 1883, pp. 136–138, and Plates IV and V.

REPORT ON BUFFALO-GNATS.

By F. M. Webster, *Special Agent.*

LETTER OF TRANSMITTAL.

Lafayette, Ind., *April* 30, 1886.

Sir: I herewith transmit a report of my investigations of the habits of the Southern Buffalo-gnat.

In accordance with your instructions I left my home in La Fayette, Indiana, on February 18, reaching Vicksburg, Mississippi, on the 20th. Learning here that these gnats appeared every season in greater or less numbers in the vicinity of Somerset Landing, Tensas Parish, Louisiana, in company with Mr. T. C. Bedford, of Vicksburg, one of the leasers of Somerset Plantation, I left for that locality on the 22d, reaching our destination on the same day.

On the 23d, the weather being very pleasant, the day was spent in riding about among the teams at work on the plantation, in the hopes of observing some of the earliest appearing gnats.

During the afternoon swarms of a species of *Anthomyia* were observed in the air, and I was informed that these were the insects that killed cattle and mules. The following day was both cold and rainy, and, in fact, during the two weeks following there were but two days of sunshine.

During this inclement weather the lakes and bayous about Somerset were carefully examined, no trace of the true gnat being found. In the meantime larvæ of *Anthomyia* were found in considerable abundance about decayed logs and among decayed leaves in the woods, and, as the planters to whom I applied for information ai-

most unanimously agreed that these adult *Anthomyia* were the depredators, it really seemed that the term Buffalo-gnat here might, like the Tent-worm and the Weevil in other localities, include a variety of insects.

Wishing to make the best possible use of time, I utilized the bad weather also by visiting our correspondent, Mr. Robert E. Craig, at Luna Landing, Chicot County, Arkansas, spending a few days there, and at Greenville, Miss., returning to Somerset March 8.

The 9th and 10th being pleasant, the *Anthomyia* again appeared, but, although very demonstrative, none were observed to alight upon the teams at work. This fact led to the impression that my information had been incorrect, and that I was on the wrong track. This proved true, for during my entire stay I never saw one of these *Anthomyia* alight on stock.

On the 11th word came that mules were being harassed by gnats on a plantation six miles to the northwest, and, on the following day, I rode out to that locality and found the true gnat in considerable numbers.

Four days were now spent in a fruitless search for the adolescent stages in the bayous and ditches adjacent to the locality where the adults had now appeared, and as many more were lost on account of bad weather.

During this time, and up to noon of the 20th, no adult gnats had appeared on the Somerset plantation. A strong northwest wind had, however, set in during the morning, and by evening the gnats were quite abundant. The next day (Sunday) the wind blew still stronger from the same quarter, and Monday morning, the 22d, found them abundant enough to cause some considerable uneasiness among the teams at work.

Fully satisfied now that these gnats did not breed in the vicinity of Somerset, I started out on horseback, and after riding for about eight miles toward the northwest reached a small stream known as Mill Bayou. Following this down stream, through the woods, the current soon became quite rapid, the banks being more or less grown up with brush and bushes, to below the water's edge. The gnats, too, whose numbers had been continually increasing, now became numerous enough to worry my horse considerably.

Finding that little could be accomplished in the way of inspecting the stream without a boat, and it being too late in the day to procure one, I returned to Somerset.

On the next day, the 23d, procuring a dugout, a thorough examination was made, not only of Mill Bayou, but of two others, tributaries to it, one of which had no perceptible current, the result being that where there was no current no larvæ of gnats could be found. As the current became sluggish a few were observed, the number increasing in proportion to its rapidity, reaching the maximum in numbers in the swiftest current of Mill Bayou; always provided, however, there was sufficient material to which to attach themselves. Thus, the larvæ would occur abundantly on one side of the stream, where a bend caused it to run very swiftly, while on the opposite side, in comparatively still water, few could be found.

Upon inquiry and personal investigation, this bayou was found to be receiving water from the Mississippi River through Lake Palmyra and Bayou Vidal, and also that its water rose and fell with that of the river itself, until the height of the latter fell below 25 feet on the gauge at Vicksburg.

It now seemed quite important to learn to what extent, if any, the other inland bayous were influenced in this manner, and, as the country is of difficult access, I thought best to visit our correspondent, Judge A. A. Gunby, of Monroe, Louisiana, whose circuit I knew comprised the entire infested territory of the northwestern portion of the State, and whom, I learned, was then at home on a short vacation.

Leaving Somerset on the 25th, and returning again on the 31st, I was, by this journey, enabled not only to obtain much valuable information from Judge Gunby, but also to examine the Washita River, and also, but very superficially, on account of recent heavy rains, the country between it and the Mississippi River.

Finishing my labors at Somerset on the 7th of April, I bade a final adieu to the country and turned homeward.

To Maj. T. C. Bedford, of Vicksburg, and Mr. J. B. O'Kelley, of Somerset Landing, I am under very many obligations. From first to last—and I made the latter gentleman's home my headquarters for over a month—both left nothing undone that could aid me in my work, or make my stay pleasant.

To Judge F. H. Faner, of Bayou Sara, Judge E. D. Faner, and other gentlemen of Vicksburg, to General Furgerson, of the Mississippi Loan Board, Judge Gunby, and Messrs. Robert E. Craig and John M. Lee, I am under obligations for both personal courtesies and aid in my investigations.

And lastly, I have had your own kindly advice and counsel, the more valuable from your personal knowledge of the country and of the insect.

Respectfully,

F. M. WEBSTER.

Dr. C. V. RILEY,
Entomologist.

There is no authentic record of the occurrence of the Southern Buffalo-gnat in Louisiana prior to the year 1850, when there seems to have been some complaint of their harassing domestic animals, but no fatality is known to have resulted. A vague rumor exists to the effect that they had previously appeared in 1846; but this lacks confirmation. The earliest record I have been able to obtain of stock being killed by gnats was related to me by Mr. Jacob Alexander, present mayor of Greenville, Miss., who states that he observed cattle being killed by gnats at Clarendon, Ark., in the spring of 1859.

A colored man, formerly an overseer, states that mules were killed by gnats near Refuge, Miss., in 1861 and 1862. General Furgerson, who came to Greenville, Miss., in 1862, with a battery of Confederate artillery, states that gnats were exceedingly troublesome to horses and mules during the spring of that year. They were also observed in Concordia Parish, Louisiana, during the spring of 1862.

In 1863 and 1864 the gnats were very abundant about Shreveport, La., and also Chicot County, Arkansas. No trouble is reported during 1865, but in 1866 the alluvial country between the Arkansas and Red Rivers lying east of the Washita was literally overrun with the pests. Mr. T. S. Coons, an intelligent planter living at the time near New Carthage, Tensas Parish, Louisiana, preserved a written memorandum made at the time the gnats first appeared.

From this record we learn that up to the afternoon of April 11 no gnats had been observed, but towards evening they came in hordes, settling upon and biting the mules and horses and throwing them into the greatest agony. Of 6 mules and 2 horses belonging to Mr. Coons, all of which were as well as usual on the morning of the 11th, the morning of the 12th found only one mule alive. In the meantime, a neighboring planter had lost 30 mules, and Mr. Douglas, on Somerset plantation, a few miles below, had lost 75 mules.

The mortality throughout the parishes of Madison, Tensas, and Con-

cordia, within a few days, amounted to upwards of 4,000 mules and horses, principally the former.

Although frequently causing more or less trouble and loss, the gnats did not again appear, generally, and in such countless myriads until 1882, although they caused serious injury in Tensas Parish in 1873 and 1874, and doubtless in other localities also.

But in 1882 they were more destructive to stock than ever before. The deer were driven from the woods, and frequently took refuge from their tormenters in the smokes, built by planters for the protection of their cattle; when in their agony they would allow people to rub the gnats from their bodies, and would even lay down in the glowing embers, or hot ashes, in their frantic endeavors to seek relief.

In 1884 the gnats again appeared in great numbers, and were fully as destructive as in 1882. Throughout Franklin Parish, Louisiana, within a week from their first appearance, they had caused the death of 3,200 head of stock. And for the first time in the history of the pest, they attacked horses and mules on the streets, and in the stables, in the city of Vicksburg, Miss.

No general outbreak took place in 1885, yet they appeared in Tensas and Franklin Parishes in sufficient numbers to kill quite a number of mules.

During the present season, although the gnats appeared pretty generally throughout the country between the mouth of the Arkansas and that of the Red River, and westward to the Washita, and along the Yazoo River in Mississippi, no fatality to stock had been reported up to April 10, and there had been little or no suspension of work on plantations on account of gnats.

Generally speaking, the Southern Buffalo-gnat may be said to infest the low, flat, wooded country adjacent to the Mississippi River and its tributaries, from the mouth of the Red River in Louisiana as far north at least as Southern Missouri.

I have found nothing to indicate that these gnats originate in large streams, or even in small ones in hilly localities, although the latter may have both a swift current and a rocky bed. The fact of adult gnats occurring in such localities, even in destructive numbers, is not of itself sufficient proof of their having originated there, as they may be carried long distances, and in immense numbers, by a strong wind. Furthermore, I have found no indication of their origin in other than perennial streams, although many intermittent bayous and small lakes were closely examined with this point in view.

From the foregoing, we are forced to the conclusion that these gnats follow the tendency of others of the genus, and breed exclusively in the running water of small streams. But besides this, there is another equally essential element, viz, something to which the insect can attach itself during the adolescent stages. As no rocks are found in these bayous and small streams, we find the larvæ utilizing wholly or partly

submerged stumps, brush, bushes, or any other material of like nature, clustering upon or making their way upward and downward with a looping gait, or attached by a minute thread-like spider web, they sway with the ripples at or near the surface of the water, often half a dozen being attached by a single thread. While these larvæ make their way up and down these submerged objects with perfect freedom, they do not venture above the water, and when about to pupate select a situation well down toward the bottom of the stream. In deep water they were found 8 to 10 feet below the surface, and also much higher up. But in shallow water they may be found in the pupal stage, clustered, one above the other, just above the bottom of the stream, their instinct having evidently taught them to provide for a sudden fall in the water. Notwithstanding this, with the water falling at the rate of 1 foot per day, I found many pupæ had been left high and dry.

These pupæ are at first of a light brown color, afterwards changing to a pinkish cast, and, just previous to the emerging of the adult, to black. During the first of these coloral epochs they are attached to these vegetable substances by the thoracic filaments, by threads about the body and at the anal extremity, somewhat after the manner of some Lepidopterous chrysalids; but during the last two the pupæ hang by the short anal attachment alone, and in this way swing about freely in the current, the adult issuing from beneath the water after the manner of others of the genus.

The time and exact place of oviposition as well as the exact length of time required for the insect to pass through either the larval or the pupal stage I was unable to determine. But when I left Mill Bayou, on March 24, the larvæ were nearly all of a uniform size and probably nearly full grown, a few only being one-fourth to one-half as large. On returning, on April 1, nearly all larvæ had passed the pupa stage, and the adults had emerged; all of those larvæ now remaining being as large as the majority were on March 24. This, besides indicating that the breeding season was nearly ended, also leaves some grounds for the inference that several broods may be thrown off, during early spring, in rapid succession; some strength being added to this theory by the fact that, as I now learned from those residing near this bayou, the cattle had been driven from the woods in the vicinity of the stream about the 20th of February. These are points which the necessarily limited period during which I had the adolescent stages under consideration, and the sudden, and to me rather unexpected, termination of the breeding season, prevented my settling.

The adult gnats are usually observed in the vicinity of places where they breed, during the first warm days of spring, and they remain from ten days to three or four weeks, seeming to prefer a moderately cool temperature; and hence, during warm weather, are more numerous in the early morning and towards evening, frequently being as troublesome during bright moonlight nights as during the day time. They are said

to spend the night among grass and like herbage. They are exceedingly active, and no sooner have they gained a foothold on an animal than they are busy at their bloody work, selecting the breast, flanks, ears, nose, or wherever the skin is the most easily punctured.

Very inconspicuous in their flight, making little noise, seldom arising more than a few feet from the ground, they often bite mules working in the fields, sufficiently to cause death before their presence in considerable numbers has been discovered. This will, perhaps, account for the prevailing notion that the bite of these gnats first appearing is the most poisonous, for inclement weather and adverse winds may cause them to appear, for the first, at any time during the breeding season, in localities where they do not actually originate, and, as will be shown farther on, the same wind that holds them back from one locality may convey them to another. It would appear as rather more probable, however, that the poison introduced into the animals' system by the bites of the first gnats, unless sufficient to prove fatal, may to some extent serve as an antidote for that introduced by those appearing later; and should this poison remain in the system with considerable stability, the fact would also account for acclimated stock being less susceptible to poison from the bites of these gnats than those unacclimated. Except in the case of great numbers, death does not necessarily follow the bite of these gnats, and even then it is not suddenly fatal. Mules that at night do not appear to be seriously injured will often be found dead next morning.

Stock, and mules especially, that have been fatally bitten by gnats are affected in much the same manner as with colic, and, in fact, many think the bites bring on that disease. But Dr. Warren King, of Vicksburg, who has made a large number of *post mortem* examinations, states that he has never been able to obtain any facts which would justify such a conclusion.

Dr. King opines that the effects of these bites from gnats are on animals much the same as that of the rattlesnake on the human system; and this seems to be the generally accepted opinion among the more intelligent planters.

In regard to artificial methods of counteracting the poison of gnats, there is of course no end, apropos to which, one planter remarks that if the gnats failed to kill the mule the remedies used certainly would. Be this as it may, I could learn of no measures that had been generally tested and proved effective, and no opportunity was offered me to make any experiments in that direction.

Dr. King recommends rubbing the affected animal thoroughly with water of ammonia, and administering internally a mixture of 40 to 50 grains of carbonate of ammonia to one pint of whisky, repeating the dose every three or four hours until relieved. The doctor claims to have never lost an animal under this treatment, although they were sometimes apparently beyond recovery. This measure I do not think

is generally known, but it certainly contains sufficient merit to warrant a thorough and careful trial. Various external applications, such as decoctions of Alder leaves, tobacco, pennyroyal and other herbs, have been tried with a view of preventing gnats from biting mules while at work, but all of these have proven ineffective. A mixture known as Gnat Oil is now the chief protection, but this is apt to remove the hair and is considered injurious to the mules. Fish-oil, and also a mixture of Kerosene and Axle-grease, are both useful, but none of these can be used to advantage on stock running at large.

Smokes made about the fields serve as a partial protection, both to teams at work and stock in pasture. Smoldering fires of cotton seed are also made in tin cans and like objects, and these are hung about the teams at work.

While these protective agencies are of considerable service when there are comparatively few gnats, they are of little value in seasons of great abundance, for then stock can only be protected by placing them in dark stables, the gnats having a great aversion to entering dark places. I am told that to look for relief from simply killing the gnats would be worse than hopeless, for, though millions were destroyed, they would not be missed.

Judging from the results of some experiments made with insecticides by myself upon larvæ of the gnats, it will be nearly if not quite impossible to reduce their numbers by killing them in the streams.

These experiments were made by confining the larvæ in glass tubes and submitting them to a current of the decoctions or solutions indicated below.

Larvæ remained in a decoction of China berries for half an hour without apparent effect, and the same larvæ immediately withstood a brine of salt water, composed of a heaping handful of salt to seven quarts of water, for twenty minutes, and still remained alive. Lime-water and sulphur and water had no effect. Strong tar-water killed them, but diluted it proved harmless. Kerosene emulsion, diluted to contain 5 per cent. kerosene, was effective, but it would be impossible to get a strength of even 1 per cent. in the stream. About an ounce of Bisulphide of Carbon was placed in seven quarts of water, but half an hour in this failed to affect the larvæ. About three ounces was placed in same amount of water, and this proved fatal within ten minutes.

From this it will be seen that while the larvæ are susceptible to ordinary insecticides, it will be next to impossible to place a sufficient amount in a stream to affect them. At the time, too, when remedial measures are the most needed these streams are swollen, and are often from ten to twenty yards wide and half as deep. Besides, both men and beasts are dependent upon these streams for their water-supply, and cutting this off by introducing poisons would cause almost as much trouble as the gnats.

Notwithstanding all attempts to combat this pest have so far been

discouraging, there is yet some hope of relief, and that, too, from quarters little expected, by myself at least, when these investigations began.

But, in order to fully understand the matter, it will be necessary to bring together, not only chronological data relating to the insect in question, but to the height of water in the large streams during the past thirty-five or forty years. Also, we must understand something of the nature of the country which these gnats inhabit, as well as the elements necessary to their production. And not only must these facts be weighed independently, but very carefully with relation to each other, for it is more than probable that it is through a combination of circumstances that the pest holds its sway.

A very noticeable feature connected with the occurrence of the Buffalo-gnat is, that below the Arkansas River there is no record of any fatality to stock, attributable to gnats, previous to the outbreak of the war, even in seasons of high water. But since that time the two have occurred in connection with such regularity that the fact has been noted by even the most unobserving; that is, in season of low water during the first three or four months of the year, there have been few gnats, but with high water during these months they were abundant, reaching the maximum during an overflow.

The banks of the rivers of this alluvial district are peculiar, in that the country slopes from instead of toward the streams. Hence water, escaping through the banks first runs inland, and then more or less parallel with the parent stream, until it can empty its waters into a larger tributary. Of this characteristic of the Mississippi, Red, and Yazoo Rivers, whether considered individually or collectively, I do not think it would be too much to say that it is one of the primary causes of the production of the gnats in such destructive numbers.

My own observations were almost wholly confined to the country lying between the Arkansas and Red Rivers on the one hand and between the Mississippi and Washita on the other. This section is of difficult access, and I have relied for my information principally upon civil engineers and other people familiar with topography of the country, as my own time was largely occupied in studying the gnats themselves in Tensas Parish.

With the exception of a low, wide ridge of country lying between Bœuf River and Bayou Mason, and extending from Franklin Parish to Southern Arkansas, and known as the Bayou Mason Hills, this whole region is very flat; and the streams, with only rain and sewage water to carry off, would naturally have a sluggish current. A glance over the map of this section will show that it is traversed by Bayous Bartholomew and Mason, and Rivers Bœuf and Tensas, the last two really not materially differing from bayous.

Three of these will be observed to originate in extreme Southeastern Arkansas, and running south-southwest, finally unite together, and form Black River, which is a tributary of the Washita.

Besides these main bayous there are innumerable smaller ones which often intersect them and each other, so that if one of the main streams becomes suddenly swollen, the water escapes from it into all of the others, and if continued, affects the whole internal water system.

These bayous all differ from the rivers, in that the descent from the top of the bank to the water is much more gradual, and this slope is apt to be more or less overgrown with brush and bushes to below low-water mark. Hence, it will be seen that whatever contributes to the volume of water in these bayous not only adds rapidity to the current, but brings it more and more in contact with the second element, viz, material to which the larvæ can attach themselves, and we have the same state of affairs as in Mill Bayou.

In Louisiana there is but one locality where water from the Mississippi gets through the bank into these inland bayous, and that is by way of Bayou Vidal and Mill Bayou, although in very high water it runs into Roundaway Bayou a couple of miles above Bayou Vidal at Diamond Bend. The next opening is at Master's Bend, a short distance north of the Arkansas line, and the water coming in through it enters both Bayou Mason and Tensas River. The next break is just above Luna Landing, and is known as Whisky Short; another, Panther Forest, is just below Gaines's Landing. Of the effect of these last two openings extracts from a letter received from Mr. Robert E. Craig, who resides on Point Chicot, in the immediate vicinity, will fully explain:

"If you will examine your map you will find Lake Mason lies at right angle across head of 'Tensas Basin.' The recent rise in the river was high enough to run into Lake Mason, the southern bank of which is high. There are two or three bayous through this bank which let the water into all bayous east of Bartholomew, but not enough water to overflow the lower banks of any one of them. Lake Chicot also filled at the same rise in the river, and is gradually being emptied through the Mason and Boeuf." Mr. Craig also adds: "When you were here, bayous were all receiving Mississippi River water through Lake Mason and Lake Chicot." It was during "the recent rise" to which Mr. Craig refers that I was his guest at Point Chicot. And on March 2d, the day after my arrival, the water measured 27.8 feet on the gauge at Memphis, and 38.2 feet at Vicksburg, as the signal officer at the latter city informed me.

It will be proper to state here that up to the breaking out of the war, owing to the perfect levee system, water was prevented from escaping into these bayous. During the war, these levees were destroyed by the caving of the river and through other causes, and the places where water now escapes from the Mississippi River and runs inland are breaks that have never been rebuilt.

As the season of high water usually occurs during late winter and early spring, the effect of this influx of water is not only to fill these inland bayous, but to keep them full during the breeding season of the gnats. Hence the effects, if any occur, should be noticeable in the

number of gnats and the amount of damage done by them in the vicinity of the streams thus influenced.

They appear in the vicinity of Mill Bayou every year in greater or less numbers, and I have twice observed them being carried from them to Somerset plantation by a heavy northwest wind, and as often observed them gradually disappear under winds blowing equally strong from the north, northeast, and south.

Strong winds, blowing from a northwesterly quarter, bring gnats suddenly and in great numbers to the neighborhood of Lake Saint Joseph, six to eight miles below Somerset. Judge Gunby states that they appear at Monroe with an east wind; Mr. Craig observes them at Point Chicot with a west or southwest wind, and at the time they appeared in the city of Vicksburg they came with a westerly wind.

Probably the worst afflicted parish in Louisiana is that of Franklin, which is situated between and at the junction of Bœuf River and Bayou Mason. Judge Gunby and others well acquainted with the country through which these two streams flow state that gnats appear with more regularity and in greater numbers in that vicinity than elsewhere. Mr. Craig states that they occur to some extent every year along these streams in Arkansas, being observed the most numerous the present season near Bayou Mason. This is in accordance with all reliable information which I have been able to obtain, and, aside from the country about Mill Bayou, coincides with my own observations.

In connection with this evidence we can also observe that these gnats are yearly being produced in numbers close up to the danger line, only an overflow being required to furnish the conditions suitable for carrying them far beyond. Soon after these investigations began I learned that the Buffalo Gnat did not occur below the mouth of the Red River. Wishing definite information on this point, I addressed a letter to Judge F. H. Farrer, of Bayou Sara, La., whose reply is given herewith, and I will only say that the facts embodied therein have since been corroborated by planters whom I have met from that region:

BAYOU SARA, LA., *March* 9, 1886.

DEAR SIR: Yours of the 4th instant was received day before yesterday, Sunday. Court being in session, a great many farmers were in town, and I had plenty of old, experienced men to apply to for information in regard to the Buffalo-gnat.

Many had been familiar with the mischief it did farther north, but all agreed that, except to young turkeys and other poultry, it worked little or no harm in this region, either in low or high lands. A few indeed asserted that the one here was a different insect, known by the name of "turkey gnat," but the large majority maintained that it was the same humpbacked individual so destructive in North and Northwest Louisiana. I presume that it never appears in such numbers here as there.

My own experience, as far as it goes, agrees with that of the majority with whom I spoke on the subject, viz, that the genuine Buffalo-gnat is to be seen here every spring for a few weeks, but is by no means the dangerous pest to cattle, horses, &c., that it is in Northern Louisiana.

Respectfully, yours, &c.,

F. H. FARRAR.

F. M. WEBSTER, Esq., *Vicksburg, Miss.*

In summing up the matter we find that so long as this influx of river water was prevented no damage occurred by reason of gnats, even in the district now the worst infested, and we also find that in other parts of the same State, where this influx is still prevented, no trouble is experienced.

Hence it seems but reasonable that, if this protection was restored, the trouble would, within a few years at most, subside to its former state. This time would be materially hastened by the removal of underbrush, &c., which would come in contact with the current in portions of these inland streams where it runs the most swiftly. This last remedial measure might also be applied to bayous affected by high water of the Red, Yazoo, and other smaller rivers.

From the fact that the gnat breeds during the season when the water is cool, and ceases as it gets warmer, it seems not impossible that the infusion of the icy current of those rivers flowing from the north into those breeding places might serve to prolong the breeding season. The truth of this point can only be obtained by future study.

It is also possible that a more extended study of the Buffalo-gnat and the entire country it infests might, to some extent, modify the conclusions arrived at in this report; but with the evidence now before me they appear correct.

THE NATIVE PLUMS—HOW TO FRUIT THEM—THEY ARE PRACTICALLY CURCULIO PROOF.

By D. B. Wier, Lacon, Ill.

During the past forty years, in the vast region of North America lying west, north, and south of Lake Michigan, and the west line of the State of Indiana, it has been impossible to succeed in fruiting the fine, large, delicious Garden Plums (*Prunus domestica*) of Western Europe, for the reasons that the trees were not hardy in this fierce Western climate. The fruit was destroyed by the Plum Curculio (*Conotrachelus nenuphar*), and of late years, if not so destroyed, "rotted," particularly south, before maturity.

Long and persistent trials of this species of plum in the West, by the most careful and expert cultivators, have proven that it is folly to longer attempt to cultivate the old and well known varieties of these plums, for in the northern part of this region neither the trees nor their roots will withstand the severity of the winters, and south, if we protect the fruit from Plum Curculio, it seldom escapes total annihilation by "rot" before arriving at maturity, and, as a rule, for many years all intelligent cultivators have given up its cultivation, and have been anxiously seeking for a substitute, and have repeatedly selected for this purpose the finer varieties of our two most common species of

NATIVE PLUMS.

The Chickasaw Plum (*Prunus chickisa*) found indigenous from Northern Illinois to the Gulf of Mexico, and the wild yellow or red plum (*Prunus americana*) found indigenous over nearly the whole continent. These are two quite distinct races (for they cannot be regarded as distinct species) of the subgenus *Prunus* of the Almond family (*Amygdalea*), order Rosaceæ. And a typical tree of either so-called species is very distinct in fruit, foliage, and general appearance from a typical tree of the other. But so far as we are concerned in this study of them they are practically the same, except that the fruit of the *P. americana*, or Northern type, has much the thicker, tougher, and more acerb skin, and that some of the Chickasaw, or Southern type, do not prove hardy far North, *i. e.*, some of the named varieties, while others do, and the same would undoubtedly prove true of *P. americana*. But as this last is found growing wild, and with good varieties, at least as far north as the northern limit of Dakota, these native plums are a fruit in some of their varieties perfectly adapted to every part of the United States and Territories and pre-eminently the fruit of the great Northwest.

Yet, as a rule, those who have taken these wild plums from their native thickets and planted and carefully cultivated them, in hope of finding at least a poor substitute for the Garden Plum, have met with a complete, decisive failure. They got no fruit. We, the older settlers of the West (Illinois), knew the wild plums as the most plentiful and useful of the wild fruits when the country was first settled and when our "tame" plums failed (for it is a fact that in this part of Illinois as early as 1845 we fruited many varieties of the Garden Plum, Nectarines, Peaches, and Apricots in abundance, with no injury from the Plum Curculio, or "rot"). We began to hunt out and plant the finer varieties of the "wild" ones, some of which were most beautiful, large and fine, and of very good quality. But after years of patient waiting we found that these gave no fruit in their new homes, except very rarely. We found that the young fruit developed to the size of a little pea, or a little larger, and indeed often to more than half its full size, and then all fell off.

This fallen fruit, if examined, showed very generally the ovipositing marks of the Plum Curculio, made when laying her eggs.

It is not necessary here to give the complete natural history of this insect, because all the more important facts and their practical bearings have been recorded by competent writers, and especially by Walsh in his first report as State entomologist of Illinois, and by Riley in his third report on the insects of Missouri; but it will be sufficient to say that it is a small insect of the Curculio (*Curculionidæ*) or snout-beetle family that deposits its eggs under the skin of the young fruit of all the smooth-skinned species of the Almond family, or nearly all of them, and some other fruits as well. The eggs are deposited in little holes eaten through

and under the skin of the fruit by the mother beetles, and so soon as deposited she cuts around and under the egg, leaving a crescent or new-moon shaped mark on the fruit, with a round dot (hole where the egg was laid) between the two horns of the crescent. In the Garden Plums, Nectarines, Peaches, Apricots, late Cherries, &c., these eggs soon hatch and bring forth white, footless grubs, which burrow through the pulp of the fruit and live and grow fat on its substance, and at the time when the fruit should mature, instead of a fine, delicious fruit, one finds, though perhaps quite fair without, a mass of rottenness within, with a nasty grub wallowing around in its own excrement, and the rotten pulp of the fruit, thereby completely destroying it for any purpose whatever as a fruit.

That the numbers of this pest have grown less each year for the past ten years, and more especially during the last three years, is the evidence of all careful observers. This grand result has evidently been brought about by the continuously-increasing numbers of its natural enemies, in the form of other insects, &c., and if this rate of decrease and increase keeps on, we may in the near future be so relieved of this pest as to be able to have fair crops of the stone fruits without using preventive measures.

So much about the Plum Curculio is necessary for the general reader in understanding this paper, and it is well to continually bear in mind that, until a very recent date, the native plums were considered as one of the fruits totally destroyed by the Plum Curculio by *all*, unless it was "Curculio proof" or protected from the parent beetle. But this belief was not and is not true, for we shall find as we proceed that all, or nearly all, of the native plums are practically curculio proof. And what is of very much more value, we will find that instead of breeding and multiplying the Plum Curculio, they scarcely breed them at all, and that if these plums are planted in sufficient quantity they will greatly reduce its numbers and protect other fruit from its ravages.

Then, of course, when we found nearly every fallen fruit marked with the peculiar marks made by the Curculio when laying her eggs, we all of us, professors of entomology, professors of horticulture, fruit-growers, and "clod-hoppers" at once jumped to the conclusion that the "Little Turk" (so called from her ovipositing mark being crescent-shaped) was the cause of the loss of our plums. We all believed this to be true; we looked for no other explanation; we had no data on which to base a search for any other explanation, so we sheathed our weapons and retreated from the field vanquished.

In the mean time what few matured plum thickets were left, the few that had escaped the farmer's grubbing hoe, continued to give annually bountiful crops of fruit, the Curculio to the contrary notwithstanding, and, whether stung or not by that insect, matured and ripened their fruit.

It is true that the trees in these wild plum patches were not as vig-

orous and healthy as they were when we gray-headed chaps were boys, for their surroundings had been changed, greatly changed. Their old companion plants were nearly all gone; new plants, usurpers, had taken their places and their environment was changed.

These new plants were many of them very injurious and detrimental to the vigor of the trees, and with the advent of man had come his herds; they tramped the ground down hard over their roots; they laid bare the surface of the soil to the direct rays of the sun by eating the herbage. Things injurious to the foliage and fruit of the trees, in the shape of new insects and new diseases, were introduced, but with all of this a few wild plum thickets survived and matured plums. Why these did mature fruit under these adverse circumstances, and why the selections we made of a few fine plums from perhaps some of the most fruitful of these same thickets could not be made to mature a plum with all the care and petting we could give them, when planted in our garden or orchard, to explain this, to give the reasons why, and to show how easily all can have this valuable and delicious fruit in abundance, is the motive of preparing this paper for publication.

And now I will begin my task. I was born here (Marshall County, Illinois) in 1834, and can therefore well remember the country as it was, and the wild plums as they were before the Plum Curculio made its first destructive showing here in 1845. Then we had these plums everywhere; "the woods were full of them." The valleys of the smaller streams were almost one continuous and unbroken plum thicket from source to mouth. The edges of the prairies were skirted with them. They were the most plentiful and useful of all our wild fruits.

As a boy I was passionately fond of fruit of all kinds, and the location of all good wild fruits that I could find was stored up in my memory for future use.

Many of the wild plums, as I remember them, growing in our woods were very poor in quality—many good, a few very good, and a still smaller proportion of them very good and very handsome.

About the year 1844 I found growing in the edge of a plum thicket a beautiful young tree, with a few large bright golden plums on it, kissed by the sun until their cheeks blushed crimson, and, when ripe, of delicious, honeyed perfumed flavor, large, oblong, and most beautiful. The next fall it was fairly loaded with its glorious fruit. I determined to secure this prize and have it all my own. I took it up very carefully, transplanted it into the garden, and tended it with the greatest care; it grew finely in its new home, but never matured a fruit; it bloomed and set fruit freely, but it soon all fell off, but they were *not stung by the Plum Curculio!* It was before the advent in great numbers of that now numerous pest.

I next tried the European or Garden Plum; they bloomed, fruited, but every plum was destroyed by the Plum Curculio before maturing.

At last a dry autumn, followed by a severe winter, cleaned these out, roots and all.

I next heard of a variety of the Native Plums called the Miner; heard a great mass of testimony as to its being thoroughly hardy, entirely "curculio proof," and yearly productive of good, large, salable fruit. I procured 500 trees of this variety and planted them in an orchard, the spring of 1862, and, with the exception noted farther on, these trees have not to this day matured one peck of fruit. This variety is about half way between or a hybrid between the extreme types of the two species first mentioned. I next learned of the celebrated plum of the Southern or Chickasaw type, known as the "Wild Goose" plum, in 1867. I procured a few scions of it, and top-grafted them in the center of the Miner orchard. Five of these grafts grew, and the next spring the grafts bloomed freely and set a large amount of fruit, nearly every one of which matured fully. The great, bright red oblong fruit hung on ropes on these grafts, and I was so excited over them that I nearly went plum crazy. They ripened the first half of July and they were snapped up in our little town at 25 cents per quart. In my dreams I saw golden visions; a fortune from plums stared me in the face. Thinking all was right with this plum, so soon as I could obtain trees I planted 800 of them in orchard. They grew and flourished grandly, bloomed, and they set fruit profusely, but it all fell off when quite small. Both these Miner and Wild Goose orchards were planted in a solid mass, no other trees of the almond family being among or near them, except as hereafter noted.

I have said the grafts set in Miner bore profusely, so did the trees in which they were grafted, *i. e.*, of Miner Plums, as did the trees next adjoining, and matured their fruit perfectly. These plum orchards were both a continuation of a large orchard of hardy cherries. The rows of both varieties of these plums next to the cherries have *every year matured more or less plums*, some seasons quite a crop. With these exceptions, no other trees in these orchards have ever brought one plum to maturity. These two orchards were some distance away and so were not observed very closely. In carrying on a general Nursery I gathered here many varieties of Native Plums, and propagated them quite extensively for sale. Trees of the leading varieties on their own roots were planted isolated from other plums, so as to obtain suckers. The varieties so planted were Wild Goose, Miner, Forest Garden, DeSoto, Weaver (though not to be true to name), Langdon, Newman, and many others, none of which have as yet matured a plum except the Newman. About the same time, or sixteen to eighteen years ago, I planted the varieties named above, together with several others, thickly in rows, the rows four feet apart, with the several varieties intermingled or "all mixed up," but at some points in the rows all of one variety with no other quite near, and *these trees* have not failed of bearing and maturing a full crop each year during the last twelve years. Again soon after this I planted

in nursery rows for budding 2,000 one-year-old seedlings of the Americana type, from seed grown in Wisconsin. These were planted in two blocks and were budded over once with the varieties last named, and some others. The rows were four feet apart and the seedlings one foot (or less) apart in the rows. But a small percentage of the buds grew, the best of the resulting budded trees were sold, but more or less trees of all the varieties so budded were left among the seedlings and all grew up together and are yet, to-day, to be seen in the same condition.

Of the trees planted not near other trees of the Almond family, numbering some hundreds, not one of them ever matured a fruit during the sixteen years they have been old enough to produce, until last season, when a few of the varieties ripened a very high crop of fruit, the Miner being second only to the Newman in point of productiveness.

The Newman as an exception to the other varieties has given a fair crop each season during the sixteen years, except one, when it failed entirely. Ten years ago I was ready to retire beaten, and give up the whole plum and plum-tree business in disgust, in fact the whole Almond family, for the Plum Curculio seemed determined to destroy all the cherries also. I had followed every hint and theory that I had ever heard of. I carefully examined the flowers of all the varieties, and found them, so far as I could see, perfect in all their parts. The first grafts of the Wild Goose in the Miner trees continued to bear each year, as did the trees in which they were grafted. The isolated trees, scattered over the plantation, were vigorous, healthy, and each year bloomed profusely and set fruit freely, but it all fell off when quite small, except a very small proportion of that on the Wild Goose; some of the fruit of this variety would attain half, two-thirds, or even full size, ripen prematurely and then fall off. But in all such instances there were other trees of the Almond family planted not far away, and I can safely say that during the twenty years or more that I have had this variety old enough to bear, the hundreds of trees of it in my orchards have not matured one fruit if completely isolated from other trees of the Almond family.

One day, when examining the fruit of this variety for Curculio young, I was surprised not to find a live grub in them at all, and at that time could not find a fruit in which the larvæ had ever fed. And I was still more surprised upon cutting through the shell to find that the seed had not developed and was imperfect. This fact led me to believe that the flowers of this variety were not perfect, that the pollen was not good.

Some years ago I received from its disseminator, O. M. Lord, of Minnesota City, Minn., scions (grafts) of a fine new hardy plum found in his neighborhood, named the "Rolling Stone." Five of these I grafted into a tree of Wild Goose of bearing age by splice grafting on the terminal twigs of the main branches. All five of these grafts grew; one of them gave three clusters of bloom the same spring it was grafted,

and matured three plums. I was very greatly surprised this same season, in July, to find near this graft, and in the same tree, about twenty-five perfectly matured Wild Goose plums, all very close to the Rolling Stone graft and none any distance from it, and the Wild Goose did not ripen prematurely or fall off before fully developed. The three plums matured by the graft ripening about a month later.

Three of the Rolling Stone grafts grew finely the first summer after grafting, and the next spring bloomed profusely. The tree in which they were grafted grew at the south end of a row of the same variety (Wild Goose) about 30 rods long. This second season after the grafts were inserted the tree in which they were growing matured a full crop of fruit; the one next north 4 feet from it was full of fruit on its south side; the fruit was scattering. The next tree 10 feet north of the grafts matured three plums; not one other tree in the row out of perhaps a hundred matured a plum that season.

The extreme cold of the following winter destroyed the Wild Goose below the grafts, and the following spring they did not bloom. Twenty feet east of this row of Wild Goose stood a row of cross-bred seedlings. The following summer (of 1885) this row of seedlings bloomed and fruited enormously, and the row of Wild Goose fruited very heavily on the east side of the trees, with scarcely a plum on the west side of the row.

And to close the record of these two rows, I will add that during the spring of 1886 I made a record of the time of blooming of all the plum trees on the place, and of the force and direction of the wind during the time of blooming, and find, by referring to that record, that a gentle east wind prevailed for three days during the time when the row of native plums were in the height of bloom, and the row of Wild Goose matured an enormous crop of very fine fruit, but with very much more fruit on the east than on the west side (the row of seedlings furnishing the pollen which was wafted to them by the east wind.)

The first year that the Rolling Stone grafts bloomed gave me the long-hidden secret of the failure in productiveness of the native plums, which has proved itself to be that a great majority, or nearly all of them, are not fertile with their own pollen; or, in other words, from some not as yet fully explained cause or causes the pollen of, say, the Wild Goose or Miner will not pollenize the ovaries of their own flowers. Why it will not does not become material; the fact remains, nevertheless.

After a pretty thorough investigation my conclusion as to the reason is, that the pollen matures and is flown away and wasted before the stigmas are mature enough to receive it; or, it may be true that the pollen of some varieties is impotent to their own stigmas, or possibly even poisonous to them. That this latter condition of facts may exist has been fully and satisfactorily proven by the most carefully conducted experiments by the great Darwin, and the results given in detail in his

"Plants and Animals under Domestication," and the same theory has to some extent been handled in works by other eminent scientists. I found that the Rolling Stone variety would pollenize the Wild Goose and render it fruitful. I found that other varieties would do the same when twenty feet away, if the wind blew from the right direction when they were in bloom. I found that in every instance where I had trees of the Miner and Wild Goose near each other, both varieties were very productive, and also that when the Newman and Wild Goose were near together neither was fully productive, and that where Miner and Newman were contiguous both were enormously and regularly productive.

I also found that where I had Newman growing isolated from other varieties, that it was yearly productive of moderate crops of good fruit, but scarcely a seed from such trees would grow; but where the Newman and Miner were planted near together the Newman was not only enormously productive, but the fruit was larger, later, darker colored, and thicker skinned, and the seed all good, and the resulting seedlings strong and vigorous, the Miner being also very productive in this case.

Further, I found that where I had nearly all the named varieties of both types of these plums growing together in the two blocks of seedlings, that all of them (including the seedlings) were, with the exception of the Wild Goose, very productive each year since old enough to bear. Trees of the Wild Goose were growing in both blocks of these seedlings, but none of them have ever fruited so heavily as those growing near Miner, showing, I think, that the Miner is its best consort. The trees in these two blocks of seedlings are about one foot apart in the row, and the rows four feet apart. Growing in this way much in the same manner as the natural plum thickets of the earlier days of this country, they have all of them matured a full crop of plums each year for the past seven years, and the trees have remained more vigorous and healthy than isolated trees of the same varieties. The number of varieties in these two blocks may be safely estimated at 5,000, running through all grades of the northern wild plum, from the poorest to the very best. During the whole period in which these plums have been fruiting, nothing whatever has been done to protect the fruit from or to destroy the Plum Curculio, and this insect has been present in large numbers during the whole time. No hogs or other stock have been allowed to run among the trees, and, until the last three seasons, all the "wormy" fruit has rotted on the ground, undisturbed.

The history of these plum trees tells my readers exactly how to fruit the native plums everywhere in abundance. Heretofore when writing on this subject I have qualified the above by saying how they will fruit *here* abundantly. But during the past two years I have corresponded with the owners of or visited a great number of plum orchards throughout nearly the whole country and find the same results everywhere, namely, wherever these plums have been planted with several varities near together (or near trees of several other species of

the almond family) they have been constantly productive, but when planted with the varieties isolated they have proven barren, except in the South.

While the Wild Goose will pollenize its own stigmas south of the Ohio River, and will not north, may seem a little strange. But this fact is easily explained. Here, or North, fruit trees burst suddenly into bloom, and in three or four days the sexual organs of the flowers have matured, performed their functions, and lost their sexual force. South, the peach is often in continuous bloom for four months, the plum for two months, and therefore there is a continuous supply of ripe pollen and ripe (stigmatic) stigmas to receive it. Here the Wild Goose plum, for instance, opens its flowers one day, ripens and sheds most of its pollen the forenoon of the next day (the pollen of the plum, which is the male element of their sexuality, consists of very minute roundish, egg-like cells, very light and produced in great abundance, and may be carried by the wind for miles under favorable circumstances and their potency remain unimpaired), and not until the afternoon of this day do the stigmas take on the sexual heat and become ready to receive it. These and the other fully established facts, that to many varieties and species of plants their own pollen is neither acceptable nor fertile to their own flowers—stigmas—and to the more common fact that in many plants a flower is not fertile with pollen of that flower, but fully fertile with pollen from another; why we have failed to get fruit from many varieties of Native Plums when not growing near other Plum trees (or other trees of the Almond family), and why these same varieties are very productive when planted near others; the reason for this seems to be that nature abhors "in and in breeding," or, in other words, she has carefully guarded nearly all forms of life from unnatural unions or a too close consanguinity of offspring.

But in our Almond family the different species seem freely to fertilize each other sexually in many instances, and the resulting hybrids are, so far as observed, fully fertile with all. For, as before intimated, I have absolute and incontestable proof that the flowers of the Wild Goose and Miner plums are fertilized to a limited extent by the pollen of our cherries, which belong to a different genus of the same order. Also, the proof is absolute that the pollen of the peach freely fertilizes the flowers of the Chickasaw plums, at least some of them. The new early peaches, such as Hale's Early, Amsden's June, Alexander, &c., are such hybrids nearest the peach in their generalities; and the Blackman, Golden Beauty, and other so-called plums are such hybrids more nearly resembling the plums.

The plums of Europe freely fertilize our native plums, and *vice versa*. So far there is no proof that the sub genus, *Padus*, to which our wild cherries belong, is sexually fertile with other members of the sub order, but it is very probable that it is not.

We have now, if we have read understandingly, learned how we may

everywhere in abundance. How? Simply by planting several varieties near together or commingled, or by grafting or budding barren trees with one or more different varieties as above explained. Planting the different varieties near together is most practical, and easily done by selecting such two (or more) varieties as will pollenize each other, and planting them alternately in rows 4 to 6 feet apart, the rows running in the direction of the prevailing winds at the blooming time of the plum. If we do not know what varieties will pollenize each other, we will be safe if we plant several varieties in close proximity, so as to have the so-called species alternate in the rows. The rows may be 15 to 30 feet apart.

We now take up the

PLUM CURCULIO (*Conotrachelus nenuphar*)

understandingly. But why need I add one more word about it, for the proof is absolute here, and I have the same complete proof from nearly every State and Territory, that it has no effect on the fruiting of the great majority of our native plums whatever. If their flowers are pollenized they give regular crops of valuable fruit as any fruit in any climate, with no material damage to the fruit, except rarely to a few varieties, by this pest. In fact, I will here put it on record: I believe that after carefully investigating the subject throughout three seasons, that what effect this curculio has on these fruits tends to benefit the tree and fruit rather than injure, for, where these plums are fully pollenized their tendency is to overbear—to set more fruit than they can or should bring to maturity. The most material injury to this fruit by the curculio is that the cuts through the skin of the young fruit, made by her when laying her eggs, sometimes forms a *nidus* (breeding place) for "fruit-rot." The varieties will be affected by this very differently in different locations and climates, but this rot does not, as is the case with some other fruits, so far as is known prevent our securing full crops of some varieties everywhere. (Curiously the evidence is that *P. chickasa* is more subject to rot South than *P. americana*, and *vice versa*. But my observations here prove that this "fruit rot" in the native plums more often finds a *nidus* or origin in the minute punctures of leaf lice (*Aphididæ*) and plant bugs (*Hemiptera*). The most injurious of the bugs to the fruit of our native plums, and perhaps the most injurious insect of North America, is the now notorious tarnished plant bug (*Capsus oblineatus*, Say.). This pernicious bug is abundant nearly everywhere, is an omnivorous feeder, and not only depletes trees and plants of their juices, but the puncture of its beak is very poisonous to them, causing many young fruits to drop soon after being punctured, on others leaving wounds for the entrance of the spores of the sporadic diseases or "rots." Therefore it will not do to give the plum curculio credit as the

destroyer of all fruit that falls before maturity; and, further, it is a fact that the injury to the young fruit by this curculio when laying her eggs does not cause such fruit to fall while small, but the contrary is true. Therefore, when we find all our young plums on the ground early in June, notice if every one of them shows the ovipositing mark of the Little Turk. She or her work was not the cause of their fall. But cut them open and you will invariably find the seed embryo dead, or the lice or bugs before mentioned had caused their death.

Then it remains to give a short summary of the facts gathered, showing the true status of the Plum Curculio in regard to fruit growing generally and the Native Plums especially.

The first and most important is that all evidence shows that this insect seeks the Native Plums in preference to all other fruits in which to deposit her eggs. This is a queer, a strange fact in biology, which naturalists will be inclined to dispute, namely, that an insect should seek and use, seemingly by preference, a fruit in which to lay her eggs wherein but very few of them will hatch and in which but few of such larvæ as do hatch can be nourished on its substance to maturity.

The reason why the Plum Curculio does seek the Native Plums to oviposit in seems to be because of their very early and very fragrant bloom. This beetle, unlike some others, is a ravenous feeder while in the imago or beetle state, and flies toward the nearest inviting food. With what result, now becomes the important question. I have shown that the depositing of the eggs of the Curculio in the young fruit does not cause it to fall before reaching maturity; that it does not materially injure the fruit, for I have marketed a Miner plum on which were eighteen of the ovipositing marks of this beetle, and yet it was a passable plum for use (eating or canning). But the facts are best given in figures and percentages.

During the past two seasons I have gone over the great mass of native plums in bearing here twice during each season, or four times systematically, and very carefully, with practically the same results each time, and I will here give my results in figures.

I found that for every egg that hatched and the larvæ had fed noticeably, that there were from 1,500 to 1,900 ovipositing marks of the Curculio, and that only one living curculio maggot was found in 3,100 to 3,500 plums examined and in which her eggs had been laid. These percentages are from the June observations of these two years and coincide with previous observations. In the two observations made during the latter part of July and first of August the percentages were not materially changed or different. Another study was made to find out how many larvæ that had hatched had fed to well advanced maturity as larvæ. To get at this I selected the fruit of the Wild Goose and Newman, in which I had found more living larvæ than in any other variety here (as yet I have not found any living larvæ of considerable size in the Miner, but strangely I found more living, well fed, healthy

looking larvæ in *P. americana* in the woods, to the number of plums stung than I have in any other plum, a not very careful survey of this tree showed that about one in twenty-five of the eggs laid in the fruit has produced well-grown, healthy looking larvæ). I selected first 100 plums of the Wild Goose variety, in which eggs had seemingly been laid. (I am well aware that in many species of insect life the females will continue to form proper *nidi* for the reception of her eggs long after her supply of eggs has become completely exhausted; in fact, as a rule the "grim messenger" finds her busily at work, with feeble effort, trying to lay eggs and reproduce her kind, and it is quite probable that our "Little Turk" possesses this instinct, which continues to its fatal termination. Therefore my percentages are not so correct as if I had been able in each instance to locate an egg, *in situ* within the ovipositing mark.) At least the ovipositing mark was apparent on each fruit. These were placed in a vessel, and taken out one at a time and cut under the ovipositing mark to ascertain if the larvæ had fed. If it had not fed noticeably, it was thrown aside and another taken up, and so on until I had obtained a hundred plums in which the egg had hatched and the larvæ had fed. Two trials of Wild Goose plums, in this way, gave respectively 22 and 23 living, sickly looking, attenuated larvæ. Two trials of the same number of Newman gave respectively 24 and 26 of the same kind of grubs. Whether any one of these sickly looking larvæ would have matured into beetles I do not know, but I have the best of reasons for believing that none of them would. And here are my reasons, and they are of the greatest value, if I have made no mistakes. The autumns of 1884 and 1885 I gathered the fallen fruit from all the trees for seed, and of course in this way I got all the fruit with living larvæ in them, and when selecting what good fruit there was for market, all wormy and imperfect fruit was thrown on the surface of the ground in the shade of trees, day by day as gathered, and on and convenient thereto were placed several contrivances, such as the young beetles are known to seek as soon as they emerge from the ground for shelter. These shelters were carefully examined until cold weather without finding a single beetle.

The next spring this seed was gathered up early and planted. A good portion of the ground it had occupied was at once covered with strong canvas, with its edges so covered and fastened down that it was improbable that the beetles could escape from under it.* Now, if this 80 bushels of plums selected from the 264 bushels marketed on one season, and of course including practically all the wormy plums, bred no Curculios, and it takes 3,200 eggs to produce one well-matured larva, and if we give it all the Native Plums it may require in which to lay all of its eggs,

* This experiment was very poorly conducted and proves nothing. If the plums referred to were wormy, it is safe to say that at least a portion of the larvæ were in healthy condition and went through their transformations under ground. We have

this is the pertinent question: Does it not seem conclusively to show that when this great western region, the timbered portion of it, was, we may say, one vast Plum thicket, that there were then plums enough to hold the Plum Curculio entirely in check? And, further, does it not also show conclusively that if we now plant a sufficient number of these plum trees to produce fruit for the beetles to feed on and lay all of their eggs in, and such eggs do not hatch, as we have seen, that they, the plums, will again reduce its numbers below the point of practical injury, and in this way protect all our other fruit from its depredations? Again, do not our facts show, that if it is true that the Plum Curculio is attracted by these plums early in the season, and being there on the plums she will therefore lay her eggs in them exclusively, and that by planting these plums unstintedly among and around our Peaches, Apples, Cherries, and other fruits liable to injury by her, that we will protect these fruits from damage by this beetle?

We have but one question of importance to answer, which is, Are the Native Plums a fruit worthy of extended cultivation? I can answer this question emphatically, *Yes*, they are. They are one of the most certain of the fruits in the regularity of their crop, and the yield is usually abundant, the fruit wholesome, attractive, and easily gathered, and can be shipped any reasonable distance to market. When thoroughly ripe it is delicious, eaten in a natural state—that is, some varieties of it; others are among the finest of fruits for preparing in the various ways known to the culinary art—stewing, canning, drying, preserving in sugar, sweet pickling (spicing), &c. And many of the varieties of the Northern type will keep perfectly throughout the winter if simply placed in an open earthen jar and covered with water. They all make most

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had some experience with the larvæ of this insect, but should scarcely venture to discriminate between sickly and healthy individuals as Mr. Wier has done. The precautions taken to observe and count the beetles emerging from the ground were entirely insufficient for the purpose, as the tendency to secrete under traps is manifested chiefly in cool weather in spring.

Moreover, Mr. Wier's statements that the planting and cultivating of the Wild Plum will protect our peaches, apricots, cultivated plums, &c., and effect a decrease in the numbers of the Curculio, are mere assumptions and contrary to experience. The fact that these cultivated fruits were badly infested by the Curculio as soon as they were introduced is a sufficient proof that the Curculio shows a decided preference for these plants. While we would not discredit the correctness of Mr. Wier's observation that a large proportion of Curculio eggs laid in Wild Plums fail to hatch (because they often thus fail in cultivated varieties and in cherries, pears, and apples), yet we do not believe this fact has much influence on the general decrease of the Curculio. The Wild Plums were the original food-plant of the insect and it has "existed as a species" on this plant from time immemorial. The cultivation of peaches, apricots, cherries, &c., simply furnished the means for it to increase, and only the complete abandonment of their cultivation would re-establish the original relative scarcity of the Curculio. The state of affairs would be quite different if Mr. Wier could show us how to compel the insect to oviposit in the fruit of the Wild Plum, or could even prove by satisfactory scientific evidence the truth of his assertion that it has a preference for said wild fruit.—C. V. R.

beautiful and delicious jellies. Such are the principal uses of the fruit. The trees will thrive on any soil that will support common trees, but do best on a deep, rich, moist soil; they thrive finely in the bottoms of deep, steep, narrow ravines and along drains, on lands too rough for cultivation, if reasonably rich. The trees are natural to crowded situations, crowded by each other, and by other trees; their roots do best rambling through moist soil, shaded from the sun, and the trees do very much the best in a location sheltered from the strong winds of spring (which blow away the pollen). The trees are easily propagated; they throw up young trees (suckers) freely from their roots; therefore when planting these plums on the thicket plan in waste places it is best to have them on their own roots. Or, if we do not wish them to produce suckers, they may be budded on the Chickasaw variety known as Mariana, which variety grows freely from cuttings, is quite hardy, and seldom, if ever, throws up suckers from its roots. In the South these plums do finely when budded or grafted on peach (which do not sucker), but care must be taken to prevent injury from the Peach Borer (*Ægeria exitiosa* Say). North they do nicely if "root-grafted" on peach. Generally, as the reader will have learned from this paper, the Native Plums have no very noxious insect enemies or diseases here or over the country at large, and it is safe to say that they in some of their varieties or tribes can be grown profitably in every part of the country. There is a vast amount to be learned about them as yet, and some very important facts to determine. The most valuable one is this: I have some proof that certain varieties of these plums will breed the Plum Curculio freely; if so, such varieties should be searched out and destroyed, and we should be sure not to plant these varieties for fruit, be that ever so fine.

THE SERRELL AUTOMATIC SILK REEL.

By Philip Walker.

In previous reports the new Serrell automatic silk reel has been frequently mentioned, but owing to the incomplete condition of the patents upon it, it has been considered unwise to publish even such a general description as that which follows. Now, however, that these machines are in operation in Washington, it is possible to gratify the laudable curiosity of persons interested in this machinery, of which so much has been said but so little known in this country.

An understanding of the mechanical principles of ordinary non-automatic reels and of the Serrell serigraph are so necessary to a thorough comprehension of the automatic reel that, although they have already been described by Professor Riley in Bulletin No. 9 of the Division.* it is deemed wise to insert an account of them here. The quotations

* The Mulberry Silk-Worm, by C. V. Riley, M. A., Ph. D., Washington, 1886.

which follow are from that pamphlet. A further word on some of the properties of the cocoon filament and the general process of reeling is also given in order to make the descriptions which follow more intelligible.

The silk-worm occupies, in general, about thirty days in passing through the period comprised between its birth and the fabrication of its cocoon. Most of this time is employed in eating, but about five days being consumed in passing through the molts. The food consumed during the last ten days is almost entirely employed in the formation of a fluid which fills the silk ducts and which goes ultimately to the fabrication of the silken thread of the cocoon.

In the body of the larvæ there are two of these ducts, each of which is connected with an orifice called a spinneret, which is situated in the lower lip of the insect. The larva in the formation of its cocoon throws out from these orifices two fine filaments covered with a natural glue. This glue serves to stick the two filaments together and to form them into what appears to the naked eye to be one compact thread. An examination of this thread under the microscope, however, shows its double nature and its flattened section, whose width is three to four times its thickness.

The first step taken by the worm, after it has found a convenient place to make its cocoon, is to throw out a system of threads designed to form a foundation to the more compact pod. The tissue of this system is loose and is not apparently woven after any fixed plan. Once this foundation completed, the larva begins the construction of the stronger wall of its resting place, which is constructed of a firm felting laid on in figure-eight loops and in many distinct layers. Of these layers it is easy to recognize at least a dozen and to tear them apart but it is probable that in reality these might each be subdivided into many more but for the lack of instruments of sufficient delicacy.

Taking the yellow Milanese races as a type, we find that it requires about 250 fresh cocoons to make a pound and that each contains about one thousand yards of thread. These cocoons, with the inclosed chrysalides, contain, however, 66 per centum of water, which in the course of three or four months' drying will effectually evaporate. Of the total weight of these cocoons, again, but about 15 per centum is formed of silk, the balance being composed of chrysalides and the skins cast by the larvæ in their transformation. Thus, were we to recover all of the silk contained in a lot of cocoons, it would not exceed 15 per centum of the total weight when fresh, or 33 per centum of the weight when dry. It is not, however, possible to accomplish such a result, both on account of the loss caused in getting hold of the end of the thread and from the fact that it is impossible to finish the reeling of a cocoon to its very end. Manufacturers rarely obtain more than one pound of silk for each three and one-half pounds of dry cocoons employed, and it is not uncommon

for them to consume at least four pounds of raw material in the formation of each pound of their product.

Before reeling the cocoons must be cleaned by the removal of the outer system of threads which, under the name of floss, is one of the waste products of the industry.

In the filature the "cocoons are first plunged into boiling water, whereby their gluten is softened in such a manner as to render the unwinding of the filaments an easy matter. This done, they are brushed with a small broom, to the straws of which their fibers become attached. The bundle of filaments is then taken and they are unwound until each cocoon hangs by but one clean thread. These three operations are called 'cooking,' 'brushing,', and 'purging.' The first two can be accomplished mechanically, and are currently so performed in Italy and largely in France. But purging is a process to which the accuracy of the human eye and the delicacy of the human touch have so far been found necessary." The thread unwound in these processes is also a waste product, called "frisons," and has about one-fifth the value of reeled silk. In good working about four times as much silk as frisons is produced.

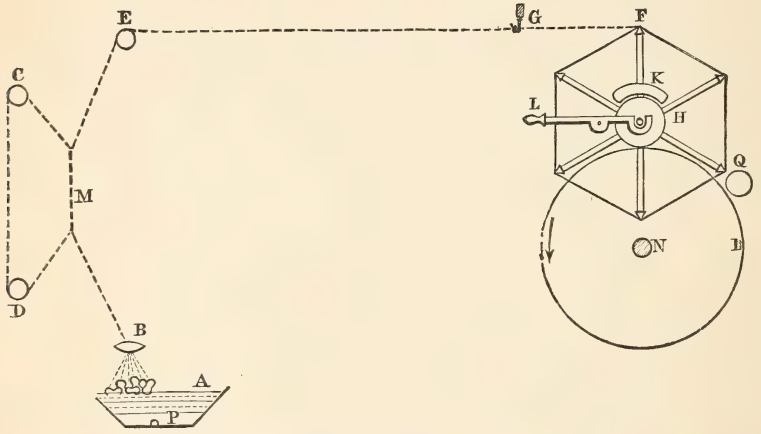


Fig. 1.—Elements of the mechanism of a modern silk reel.

"The elements of the mechanism of all modern silk reels are essentially the same. They are shown in Fig. 1, and consist, in general, of a basin, A, in which is a perforated steam-pipe, P, by means of which the water in the basin may be heated. A few inches above the surface of the water is placed a perforated agate, B. The cocoons having undergone the three operations mentioned, the ends of the filaments of four or more of them are twisted together into a thread, which is passed through the hole in the agate. From this it runs through the "croisure" M, which will be hereafter explained, and over the guide E to the reel at F. Between E and F the thread passes a guide, G, moving to and fro (in a line perpendicular to the plane ot the paper), which distributes it in a

broad band over the surface of the reel. This facilitates the drying of the silk, without which the gluten would bind together the threads of the skein as it does those of the cocoons, and thus ruin its commercial value. The shaft of the reel carries at one end a friction-wheel, *H*, which rests on the large friction-wheel I, that constantly revolves on the shaft N, and thus motion is imparted to the reel. In order to stop the reel it is only necessary to raise the wheel H from its bearings by means of the lever L. This movement presses the wheel against the brake-shoe K, and its motion is at once arrested.

"As has been said above, the thread is passed between the agate and the reel through the croisure. The making of the croisure consists in twisting the thread around itself or another thread so as to consolidate its constituent filaments and wring the water from it and thus aid in its drying. The mode of the formation of this croisure forms the principal distinguishing mark between the French and Italian systems of reeling. The former is called the 'Chambon system.' Each reeler manages two threads. These are passed through separate agates, and after being brought together and twisted twenty or thirty times around each other are again separated and passed through guiding eyes to the reel. The other system, called 'tavellette,'* consists in passing the thread up over a small pulley, *C*, down over another, *D*, and then twisting it around itself, as shown at *M*, in Fig. 1, and thence to the reel.

"The cocoon filament is somewhat finer in the floss or beginning, thickens at the point of forming the more compact pod, and then very gradually diminishes in diameter until it becomes so fine as to be incapable of standing the strain of reeling," the mean sections at these points being about proportional to the figures 30, 40, and 25. "Therefore a thread which is made up of five new filaments becomes so small when the cocoons from which it is drawn are half unwound as to require an addition. This addition might also be made necessary by the rupture of one of the constituent filaments. It is here that the skill of the operator is called into play. When her experience tells her that the thread needs nourishing from either of these causes, she takes the end of the filament of one of the cocoons which lie prepared in her basin, and, giving it a slight snap or whip-lash movement with the index-finger, causes it to wind around or adhere to the running thread, of which it from this moment becomes a constituent part. This lancing, as it is called, of the end of the filament, although in hand reeling performed in the manner described, is also accomplished mechanically, several devices having been invented for this purpose. They consist, in general, of a mechanism (occupying the place of the agate *B*), which causes a small hook to revolve in a horizontal plane about the running thread, and to twist around it any end of the filament that may be placed in the path of the hook. The reeler, seeing that a new filament is needed, holds the end of one in the way of the attaching device, and it is automatically caught."

* The trade name of the small pulley mentioned.

The thread of "raw" or reeled silk is excessively strong, ductile, and elastic. As has been seen, it is composed of several double filaments, drawn from as many cocoons. In common with other elastic threads, a given length of one of silk will resist a tendency to stretch to an extent proportionate to its mean section. This is the underlying principle of the *serigraph*. The mode of determining the irregularities existing in a thread of raw silk by means of this machine is as follows: The end of the thread is brought from the reel or bobbin on which it is wound

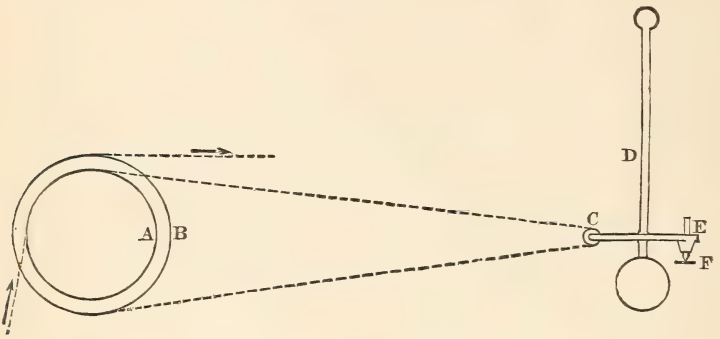
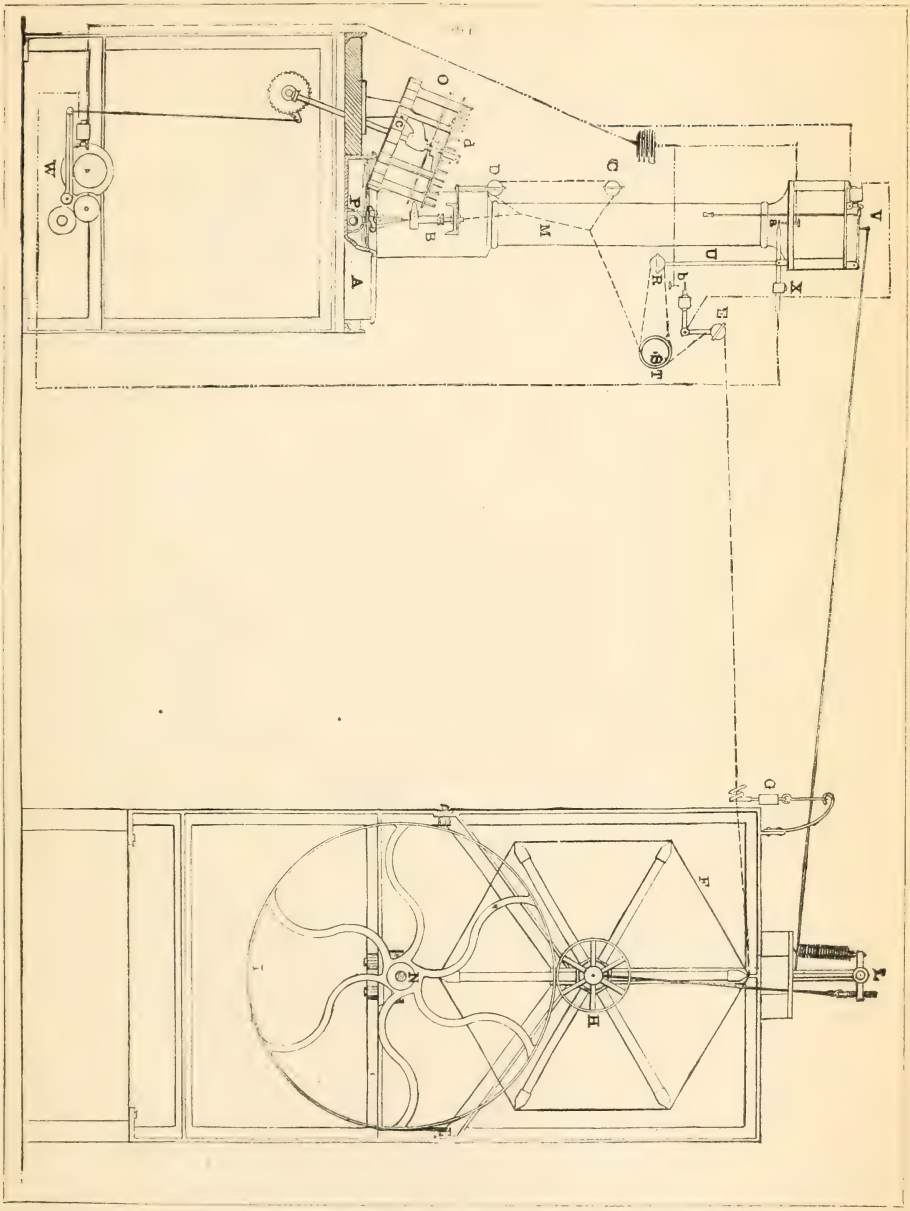


FIG. 2.—The principle of the serigraph.

around a drum, *S*, (Plate I), thence over a pulley, *R*, and back around another drum, *T*, mounted on the same axis as *S*. From the drum *T* it is wound on a reel. The drum *T* is larger than *S*, so that the former winds on the thread somewhat faster than it is paid off by the latter, and thus stretches it. In this manner we apply a constant force to the pulley *R*, tending to draw it from its normal position. This pulley is attached to the base of a pendulum, *U*, which, under the action of the force mentioned, is drawn from the perpendicular. The weight of this pendulum overcoming the force thus applied to an extent inversely proportional to the mean section of the length of thread submitted to the test, the position of equilibrium taken by the pendulum depends upon and is an indication of that mean section. The portion thus tested is that between the two drums *S* and *T*, and as, through the constant action of the machine, successive lengths of thread occupy the position indicated, the pendulum oscillates through a course which depends upon the irregularities of the thread. These irregularities are graphically recorded by a pencil, attached to the pendulum, upon a band of paper, which moves constantly under its point.

The serigraph, it will be seen, is an apparatus for continuously measuring the relative size of any thread passed over its drums and recording the irregularities in its size on a band of paper.

From this machine to the automatic reeler was but a slight transition, easily accomplished. It has been in working out the details of the desired mechanism that the greatest difficulty has been met with. The result is attained in general by causing the pendulum *U* to close an



PRINCIPLES OF THE SERGEL AUTOMATIC REEL.

electric circuit whenever the thread becomes so weak as to permit of a certain amount of stretching under the tension applied to it. The electric current due to this circuit-closing is then employed in releasing the detent of a suitable feeding device, by which a new cocoon filament is added to the main thread and its size augmented.

In the operation of the automatic silk-reel the thread is made as in an ordinary hand-reel, and passed through the centre of a filament-attaching device, *B*, thence through the croisure *M*. Thence, as in the serigraph, it is passed around a small drum, *S*, around a pulley, *R*, situated at the end of a pendulum, *U*, which is called in the reeler the control-lever, thence around the larger drum *T*, and in the ordinary way over the guiding pulley *E*, to the reel. On the end of the control lever *U* is a circuit-closing contact piece, *a*, which acts when the pulley *R*, overcoming the resistance of the thread, recedes from the drums *S* and *T*. The tension thus resisted by the thread may be regulated by the movable weight *X*, or an equivalent device.

We will now suppose the thread to be running at the desired size, and that the tension due to the stretch imparted to it by the difference in the circumferential speed of the two drums is sufficient to keep open the circuit-closing device of the control lever. It continues in this condition until, through the diminution in the size of the constituent filaments, or the rupture of one of them, the thread falls below the standard, and the addition of a new cocoon becomes necessary. Then the pendulum falls back, and the contact at *a* is closed.

Just above the water of the basin, with its edge dipping beneath the surface, is a cocoon-holding device, *O*. This apparatus, usually called the magazine, rests on a support which is mounted on a shaft around whose axis the magazine may be rotated. The magazine consists of a number of compartments, *c*, situated around the circumference of a lower disk and a number of small pins, *d*, mounted on a parallel disk a short distance above the lower one. In each compartment is placed a cocoon previously prepared for reeling, while its filament is conducted upwards and wound around one of the pins *d*. A magazine thus filled is set upon its support in readiness to furnish cocoons to the running thread as desired. Its position is such that the hook of the filament-attaching device passes just below the disk holding the pins *d*, and in such a way that a thread passing from its cocoon to the pin, which for the moment is opposite the attaching device, will fall in the path of the hook and be caught by it in its revolution.

The shaft on which the magazine turns is connected with a suitable feed movement, *W*, which consists in general of a cam to which a rotary motion may be given by a proper connection with the shafting of the filature, of a lever to which the cam imparts a to-and-fro motion, and of a magnet to whose armature is attached a detent which, when no current is passing, prevents the rotation of the cam.

Now, as we have seen above, no current passes through the electric

circuit while the thread is at its standard size; for under such conditions the lever is so held by the thread that the contact at *a* is kept open. As soon, however, as the thread diminishes in size the lever recedes, the contact at *a* is closed, and the current passing through the magnet of the feed movement *W* causes the attraction of its armature and the release of the detent holding the cam in place. Upon this occurring the magazine is advanced one step and brings a new cocoon filament into the path of the hook on the filament attaching device, which catching it up twists it around the running thread and, with the help of its natural gum, attaches it firmly thereto, at the same time cutting off the loose end. The rotation of the cam is so timed that its detent will not arrive at the stop on the armature until the new filament has reached the controlling drums and had its effect upon the position of the control lever. In the reeling of fine sizes the addition of one filament will generally be found sufficient to bring the thread to its normal size, though it is less apt to be so with larger sizes. In any case, however, if, when the rotation of the cam is completed, the electric circuit still remains closed the action of the feed movement is repeated and continued until the thread is again brought to the normal size.

Owing to the irregularities in a thread of raw silk it is impossible to obtain any measure of its size by means of a caliper or even, with any degree of ease, by a microscopical examination. Merchants are therefore obliged to content themselves by approximating its size in the following manner: They measure off upon a suitable real a skein of a given length (476 meters) and obtain its weight in the terms of an arbitrary unit called the *denier*. If such a sample skein, for instance, is found to weigh ten deniers it is called a "ten-denier silk." Now it is found that the exterior thread of a cocoon of the yellow Milanese races has a value of about two and a half deniers, so that it takes four such new cocoons to make a thread of ten deniers. When these cocoons are half unwound the size of the thread formed from them would be but about eight deniers. Now, in order to augment the thread and bring it to the normal size we are obliged to add another cocoon which, with its new thread, would increase the combined thread to ten and one-half deniers, and it will be seen that from cocoons of this race it is impossible to augment the thread by smaller increments than that mentioned. For this reason no attempt is made to produce an absolutely regular thread of silk, but reelers are content if the variation from the desired mean does not exceed two deniers in each direction. In hand-reeling, where the regularity of the thread depends entirely upon the ability of the reeler to estimate its present size and to add a new filament at the proper time, only the most expert operatives are able to make silk within the limits named. In the automatic reel, however, all this is taken out of the hands of the operative and the indication of the need of a new thread is made by the delicate serigraphic measuring device of the control movement. Its delicacy is such that when working under good

conditions it will sometimes run off an almost theoretically perfect thread. A great advantage exists in this fact, as the beauty of a piece of woven goods depends very largely on the regularity of the raw silk entering into its composition.

In addition to the devices mentioned above, the automatic reel contains an electrical stop movement by which the motion of the reel is arrested upon the rupture of the running thread. It consists of a small faller on the end of which is mounted the guide-pulley at *E*. When the thread is running the pulley is drawn in the direction of the reel and an electrical contact, *b*, placed on the faller, is kept open. Upon the rupture of a thread, however, this contact is closed and a suitable mechanical device at F is set in operation by an electro-magnet. The releasing of the lever of this apparatus enables the spring on the bell crank *L* to act on the shaft of the reel and draw its friction drum away from its bearing on the large drum *I*, and thus stop its motion so quickly that the end of the broken thread will rarely be drawn into the skein. When this apparatus works promptly and well there results a very considerable saving of time in the knotting of the thread, and less waste is produced thereby.

INDEX.

Aletia argillacea, 11.
Allograpta obliqua, 14.
Allorhina nitida, 16.
Allotria avenæ, 13.
brassicæ, 14.
lachni, 13.
megouræ, 19.
tritici, 13.
Anasa tristis, 22.
Uhleri, 23.
Angoumois moth, 16.
Anthomyia mistaken for Buffalo Gnats, 29.
Apanteles congregatus, 11.
Aphis brassicæ, 12.
citrulli, 27.
cucumeris, 27.
cucurbitæ, 27.
Ashmead, Wm. H., Report on insects injurious to garden crops in Florida, 9.
Automatic silk reel, Serrel's, 52.
Bean, insects affecting, in Florida, 21.
Bean Cut Worm, 21.
Distribution, 21.
Earlier states, 22.
Injuries, 22.
Bisulphide of carbon for squash borer, 25.
Botis repetitalis, 15.
Botrytis Rileyi, 11.
Buffalo Gnats, 29.
Amount of injury in various years, 31.
Breaks in the levees the cause of their abundance, 36.
Distribution, 32.
Finding of the larvæ, 30.
Habits of imago, 34.
History of the injury, 31.
Nature of their bite, 34.
Nature of their breeding places, 32.
Not injurious before the war, 31, 36.
Not injurious below the mouth of Red River, 38.
Pupa and pupation, 33.
Report on, by F. M. Webster, 29.
Restoration of the levees probably the true remedy, 39.
Swarms of Anthomyia mistaken for, 29.
Topography of the infested country, 36.
Various direct remedies, 34.
Vitality of the larva, 35.
Cabbage Aphis, 12.
Buckton's description, 12.
Enemies and parasites, 13.
Food-plants, 12.
Injuries, 13.
Introduced from Europe, 12.
Life-history, 12.
Cabbage Aphis Allotria, 14.
Encyrtid, 14.
Pachyneuron, 14.
Syrphus Fly, 14.
Cabbage, insects injurious to, in Florida, 9.
Mamestra, 15.
Pionea, 15.
Plusia, 10.
Distribution, 10.
Enemies and parasites, 11.
Food-plants, 10.
Injuries, 10.
Life-history, 10.
Remedies, 11.
Plutella, 11, 12.
Calandra granaria, 16.
Carbolic powder for Cabbage Plusia, 11.
Cauliflower Botis, 15.
Ceramica picta, 15.
Ceraphron sp., 13.
Chalcis ovata, 24.
Conotrachelus nenuphar, 39, 48.
Copidosoma truncatellum, 11.
Corn, insects injurious to, in Florida, 15.
Bill-bug, 16.
Mining Fly, 16.
Worm, 15.
Enemies, 16.
Injuries, 15.
-stalk Borer, 16.
Weevil, 16.
Coruna sp., 13.
Cotton Worm, 11.
Crepidodera cucumeris, 22.
Cucumber Flea-beetle, 22.
Curculio-proof nature of the native plum trees, 39.
Cynipids parasitic on Aphids, 13.
Diabrotica 12-punctata, 22.
Diastata sp., 16.
Diatræa saccharalis, 16.
Egg Plant Aphis, 20.
Distribution, 20.
Injuries, 21.
Middleton's description, 20.
Parasites, 21.
Egg Plant, insects affecting, in Florida, 20.
Encyrtus anasæ, 23.
aphidiphagus, 14
? megouræ, 19.
sublestus, 14.
Entedon diastatæ, 16.
Eucoila siphonophoræ, 21.
Eudioptis hyalinata, 26.
nitidalis, 24.
Eudamus proteus, 22.
Eupelmus reduvii, 24.
Euschistus servus, 16.
False Chinch, 22.
Florida, insects injurious to garden crops in, 9.
Gas-lime for Squash-vine Borer, 25.
Gelechia cerealella, 16.
Gortyna nitela, 18.
Insects affecting the Bean, 21.
Cabbage, 9.
Corn, 15.
Egg-plant, 20.
Melon, 26.
Squash, 22.
Tea, 21.
Tomato, 16.
Halticus bractatus, 22.
Harlequin Cabbage Bug, 15.
Heliothis armigera, 15.
Hemerobius sp., 19.
Hot water for Cabbage Plusia, 11.
Introduction, 7.
Julus multistriatus, 15.
Kerosene for Squash-vine Borer, 25.
emulsion for Cabbage Plusia, 11.
Large Cabbage Butterfly, 15.
Letter of transmittal, 6.
Lime for Cabbage Plusia, 11.
Limneria obscura, 11, 12.
Mamestra chenopodii, 15.
Mascicera sp., 17.
Megoura solani, 18.

Melittia ceto, 24.
Melon Borer, 26.
Descriptive, 26.
Distribution, 26.
Injuries, 27.
Parasites, 27.
Melon Plant-louse, 27.
Distribution, 27.
Enemies and parasites, 28.
Food-plants, 27.
Injuries, 28.
Natural history, 28.
Remedies, 28.
Synonymy, 27.
Murgantia histrionica, 15.
Nola sorghiella, 16.
Œbalus pugnax, 16.
Ortalis sp., 16.
Oscinis sp., 22.
Pachyneuron allographtæ, 15.
aphidivora, 14.
Pea, insects injurious to, in Florida, 21.
Phylloptera oblongifolia, 22.
Pieris monuste, 15.
protodice, 15.
Pimpla conquisitor, 27.
Pionea rimosalis, 15.
Plum Curculio, 44, 48.
It prefers the native Plum for oviposition, 49.
Larvæ not developing in the native Plum, 44, 49.
Plum trees, foreign and native, 39.
Curculio larvæ not developing in the native species, 44, 49.
Failure of European varieties in North America, 39.
Fertilization of native species by other varieties and species, 45.
Native species and their failure to fruit, 40.
Wild Goose Plum in the South, 47.
Plusia brassicæ, 10.
Plutella cruciferarum, 12.
Prionidus cristatus, 16.
Pyrethrum for Cabbage Plusia, 11.
Reduvius Egg Eupelmid, 24.
Riley, C. V., criticism of Mr. Wier's report, 7, 50.
Introduction to the Bulletin, 4.
Letter of transmittal, 3.
Saltpeter for squash borer, 25.
Scymnus cervicalis, 15.
Serrel's automatic silk reel, 8, 52, 56.
serigraph, 52, 56.
Silk reel, elements of mechanism, 54.
Serrel's automatic, 8, 52, 56.
Silkworm cocoon, how it is spun by the worm, 53.
preparation for reeling, 54.
Siphonophora cucurbitæ, 20.
Southern Cabbage Butterfly, 15.
Sphenophorus robustus, 16.
Sphinx carolina, 17.
Egg Teleas, 18.
5-maculata, 17.
Squash, insects injurious to, in Florida, 22.
Borer, 24.
Distribution, 24.
Food-plants, 24.
Injuries, 24.
Parasites, 24.
Remedy, 24.
Bug, 22.
Distribution, 22.
Egg Encyrtid, 23.
Telenomus, 23.
Enemies and parasites, 23.
Food-plants, 23.
Injuries, 23.
Life-history, 23.
Vine Borer, 24.
Distribution, 24.
Food-plants, 24.
Life-history, 24.
Parasites, 25.
Remedies, 25.
Syrphus Fly Pachyneuron, 15.
Teleas sphingis, 18.
Telenomus anasæ, 23.
Telesilla cinereola, 21.
Tomato, insects injurious to, in Florida, 16.
Aphis, 18.
Allotria, 19.
Distribution, 18.
Encyrtid, 19.
Enemies and parasites, 19.
Injuries, 19.
Life-history, 18.
Remedies, 19.
Thomas' description, 18.
Stalk Borer, 18.
Worm, 17.
Distribution, 17.
Enemies and parasites, 17.
Food-plants, 17.
Injuries, 17.
Life-history, 17.
Remedy, 18.
Trichogramma pretiosa, 11, 15, 17.
Tridactylus minutus, 15.
Trionyx piceus, 13.
rapæ, 13.
Triphleps insidiosus, 22.
Twelve-spotted Diabrotica, 22.
Walker, Ph., description of the Serrel automatic silk reel, 52.
Webster, F. M., Report on Buffalo Gnats, 29.
Wheel bug, 16.
Wier, D. B., Report on the Curculio-proof nature of the native Plums, 39.
Zebra Cabbage Worm, 15.